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# Household Saving: Micro Theories and Micro Facts

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# Household Saving: Micro Theories and Micro Facts

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## 1. Introduction

WHY DO PEOPLE save? J. Maynard Keynes (1936) lists eight motives which we reproduce here with one addition:<sup>1</sup>

1. "To build up a reserve against unforeseen contingencies" (*the precautionary motive*);
2. "To provide for an anticipated future relationship between the income and the needs of the individual . . ." (*the life-cycle motive*);
3. "To enjoy interest and appreciation . . ." (*the intertemporal substitution motive*);
4. "To enjoy a gradually increasing expenditure . . ." (*the improvement motive*);
5. "To enjoy a sense of independence and the power to do things, though without a clear idea or definite intention of specific action" (*the independence motive*);

<sup>1</sup> The designations in italics are our titles but they almost always follow Keynes.

6. "To secure a masse de manoeuvre to carry out speculative or business projects" (*the enterprise motive*);
7. "To bequeath a fortune" (*the bequest motive*);
8. "To satisfy pure miserliness, i.e., unreasonable but insistent inhibitions against acts of expenditure as such" (*the avarice motive*);
9. To accumulate deposits to buy houses, cars, and other durables (*the downpayment motive*).

A number of features of this list bear remark. First, it seems complete. Interpreting the motives broadly, it seems that since 1936 only the downpayment motive has been added to the list. Second, there is recognition here of considerable heterogeneity in the motives for saving. It is unlikely that a single explanation will suffice for all members of a population at any given time or even for the same person over a long stretch of time. In particular, there is a widespread feeling that the wealthy have different motives to save from the less wealthy.

Third, many of the motives are complementary. For example, households that save for retirement (the life-cycle motive) will also build up financial reserves that can be used to buffer pre-retirement income or consumption shocks (the precautionary motive). Finally, there are some motives that will lead to behavior that will be difficult to rationalize with traditional economic models. For example, the motives of avarice (or its opposite, extravagance) and independence lend themselves more to psychological explanation.

As promised in the title of this survey we shall present theory and facts concerning saving. At the outset we warn that there is a sharp dichotomy in the saving literature between the two. Although the theory is sophisticated and flexible, it is a theory of consumption; saving is simply the residual between income and current consumption. Thus the intertemporal allocation theory has led to a large empirical literature on consumption. In contrast, most of the empirical work on saving itself is descriptive and relatively atheoretical. Unfortunately the two strands of the literature are very imperfectly interwoven. The major goal of future work will be to integrate these two strands.

In Section 2 we present some of the modern theory. An extensive theory section is necessary because the past decade has seen theoretical developments which have changed radically our intuitions about consumption and saving behavior. One seemingly trivial problem we have encountered in discussing the theory is that of terminology. As an example, for many researchers the term "life-cycle model" refers specifically to a Modigliani style model with no bequests and fairly simple environments. For others the term is taken to refer to any model in which agents solve forward looking intertemporal consumption problems that

may allow for, say, bequests, habits, and liquidity constraints. Similar ambiguity attaches to the term "permanent income hypothesis" which is usually (but not invariably) attached to a model that is different from that of Milton Friedman (1957). Rather than further muddying the waters we shall avoid the terms "life-cycle model" and "permanent income model" as far as possible and refer instead to models that assume optimization as standard (consumption or saving) models.<sup>2</sup> Within this we discuss various important specific cases. The other theory section is Section 7 in which we present an outline of behavioral models of saving that largely eschew the standard optimizing framework.

The principal innovation in the standard theory in the past decade has been to allow for the precautionary motive. Although this was discussed in earlier papers it is only recently that we have come to realize that intuitions derived from models without a precautionary motive can be seriously misleading, even if the amount of uncertainty is small. Thus it is often claimed, for example, that the life-cycle model implies that the path of consumption over the life cycle should be independent of the path of income. This is a prediction of what we term the certainty-equivalence model (CEQ model, see Section 2.1 for a definition) but it is by no means an implication of more general models that allow for a precautionary motive. The move to a more general model that allows explicitly for a precautionary motive brings with it both benefits and costs. We shall deal with these at length in Section 2 but the principal benefit is that we can accommodate a much wider range of behavior in the precautionary model. One

<sup>2</sup> Even this is contentious; some researchers have used the term "standard" to refer to, for example, the Modigliani model or the permanent income model.



of the costs is simply the converse of this: we have far less sharp predictions from the more general model. The other principal cost is in tractability: almost always, we are unable to derive closed form expressions for saving and consumption functions and we cannot reproduce many of the manipulations that are possible on the CEQ model.

After the theory section we present some facts (Section 3) concerning saving by U.S. households. Section 4 deals with one specific phenomenon: the apparent decline in the U.S. saving rate in the recent past. In this section we also discuss some of the possible explanations for the decline in an ad hoc way. This ad hocery is imposed on us by the relative ignorance that still surrounds the reasons why households save. Many attempts have been made to dispel this ignorance. In Sections 5 and 6 we consider some of the evidence for and against various theories of consumption. Section 5 concentrates on the short-run allocation of funds over time (particularly Euler equation studies of consumption) while Section 6 is concerned with the longer run.

We shall not be dealing with a number of topics that readers might expect to see treated in a survey on saving (see Mervyn King, 1985, and Angus Deaton, 1992, for excellent surveys of saving behavior). We ignore almost entirely the voluminous literature that uses aggregate time series data. Although the profession has learnt a great deal about the modeling of intertemporal allocation from empirical work on aggregate time series data it is our belief that we have learned almost nothing useful about individual behavior itself from this work. We also restrict attention mainly (but not exclusively) to U.S. data. Thus we do not have much discussion of international comparisons. This is not because we do not think that such comparisons are useful

but simply because we must draw the line somewhere; this survey is already very long. Interested readers are referred to the volume edited by James Poterba (1994) that compares saving rates in the G7 countries. Another important topic that we largely ignore is intergenerational transfer behavior generally and bequest behavior in particular; see Gale and John Karl Scholz (1994a) for a discussion and references. We also have very little to say about portfolio choice; this is largely because there is relatively little work on this that uses micro data directly. Closely related to this is the accumulation of assets for households by firms (in the form of retained earnings) and government (in the form of pensions); we shall not treat the determination of these assets directly although we do allow for the impact of their accumulation in the determination of household saving. We shall not, however, review in any detail the very large literature on the effects of pensions on household saving; see Gale (1995) for a recent discussion and references.

## 2. Models of Saving and Consumption

### 2.1 The Certainty-Equivalence Model

The usual model for discussing the intertemporal allocation of money and time is the life-cycle model. This takes its inspiration from Franco Modigliani and Richard Brumberg (1954), and Friedman (1957)<sup>3</sup> but in its modern form it is a good deal more general than either of the two variants these authors present. The central tenet of the modern view is that agents attempt to keep the marginal utility of expenditure constant over time. We refer to this as the *standard consumption model* (or standard model, for

<sup>3</sup> See Thomas Mayer (1972) for an excellent discussion of the antecedents of the "new" theories of consumption that arose in the mid-50s.

short). A formal derivation is given below but the entirely plausible informal argument is that rational forward looking agents will not want expenditure to be worth more (in discounted utility terms) in one period than in any other. Because the marginal utility of expenditure and expenditure itself are monotonically related this leads to "smoothing" of consumption. This principle governs both short-run (business cycle/high frequency) allocation and long-run (life cycle/low frequency) allocation. Thus agents seek to equalize the marginal utility of money from one period to the next and between now and the distant future. It is the simultaneous consideration of the short run and the long run that gives the standard model its power.

It is important to emphasize that the modern view that agents seek to equalize the marginal utility of expenditure over time is consistent with the existence of imperfections in the capital market and with habits or satiation. Thus liquidity constraints may cause the marginal utility of expenditure to fall over time (as consumption grows over time) in an expected way. This is consistent with the standard model: agents would prefer to have more consumption in the early periods but capital market imperfections prevent this. Indeed the most general model that allows for capital market imperfections and nonadditive preferences over time does not seem to impose any restrictions on the time path of consumption and asset prices. It is only when we impose restrictions on preferences and budgets that we can derive testable implications. Thus the standard model in its most general form is better thought of as a framework than as a direct source of testable propositions. We now consider the sets of restrictions sometimes used.

One collection of assumptions has been used widely; we refer to the model

that uses these assumptions as the *certainly-equivalence model*<sup>4</sup> (CEQ model):

*Assumptions for the CEQ model.* Agents have intertemporally additive utility functions and face perfect capital markets. Either there is perfect certainty or agents maximize expected utility; they form rational expectations and have quadratic utility functions.

This set of assumptions allows us to capture some of the motives for saving listed at the beginning of this survey, namely the life-cycle, intertemporal substitution, and bequest motives.<sup>5</sup> However, many of the other motives that are consistent with a standard optimizing model are ruled out. Thus, the enterprise and downpayment motives are not consistent with the perfect capital markets assumption while the improvement motive is ruled out by the assumption that the utility function is additive over time. Finally, the quadratic utility assumption rules out the precautionary motive.

The implications of the CEQ assumptions for consumption and saving have been investigated thoroughly over the past 40 years and were well understood by the mid 1980s. Very broadly, the implications for consumption are (see Deaton, 1992, for a very clear account): the shape of the lifetime path of consumption is independent of the shape of the expected path of income; the marginal propensities to consume out of current and future expected income are the same; the marginal propensity to consume out of future income is independent of the riskiness of this income; the

<sup>4</sup> Although widely used, the CEQ terminology is not universally accepted. Some investigators refer to this variant of the life-cycle model as the Ramsey model or as the Permanent Income Hypothesis (PIH) or Rational Expectations PIH (RE-PIH). Given the care that Friedman (1957) takes to allow for the precautionary motive and the emphasis he places on liquidity constraints this latter terminology seems to us inappropriate.

<sup>5</sup> The bequest motive is incorporated into the additive utility function.

elderly should run down assets; anticipated changes in income have no effect on consumption; and consumption changes are orthogonal to past information. Of course, most of these implications are highly interrelated and all are ultimately derived from the proposition that agents keep the expected marginal utility of expenditure constant and the fact that the latter is linear in consumption for quadratic utility functions.

One significant recent addition to our understanding of the CEQ model is in the incorporation of nonstationary income processes. The central insight here is that although consumption changes are uncorrelated with anticipated income changes, the actual path of consumption may follow quite closely the actual path of income if the latter displays some persistence. To take an extreme example, suppose that the planning horizon is infinite and that the discount rate equals the real interest rate. If income is a random walk then all income changes are surprises and consumption is set equal to income in every period. In this case we have a perfect coincidence between consumption and income even though the agent is formally smoothing. More generally, the relationship between income and consumption volatility depends on the income process and consumption may even be less smooth than income for plausible income processes; see Deaton (1992, ch. 4) for references and further discussion.

Many of the implications of the CEQ model implicitly employ supplementary assumptions. For example, the conclusion that consumption and expected income paths are independent implicitly assumes that consumption and labor supply are additively separable. If they are not, then consumption and expected income may be correlated. For example, many people anticipate retirement a long way ahead. If consumption and labor

supply are complementary (perhaps because of the costs of going to work) then on retirement both income and consumption fall. Even though the fall in income is anticipated, behavior of this sort does not invalidate the CEQ model. As another example, the orthogonality between consumption changes and past information holds only under special circumstances. For example, if parents pay for child care during the day when children are of preschool age these costs can be a sizable share of total consumption. Typically these costs fall or even disappear when children start school. The latter event is anticipated some time ahead so that we can predict the change in consumption using past information. Thus the orthogonality implication is once again dependent on the implicit assumption that the marginal utility of expenditure does not depend on (predictable) events.

Although tractable, the CEQ is restrictive. Less restrictive alternatives are available. For example, we can retain the quadratic utility assumption and drop one (or more) of the other CEQ assumptions. Generalizations include allowing for imperfections in the capital market; utility functions that are not time additive; nonconstant discount factors; and preferences that do not satisfy the expected utility axioms.<sup>6</sup> The quadratic utility assumption itself is, however, unattractive so that another line of investigation drops this assumption; this leads to a model which has been the focus of a great deal of theoretical work in the past decade.

## 2.2 *The Standard Additive Model*

In this subsection we discuss the model without the assumption that util-

<sup>6</sup> We do not consider this extension below because it has not yet led to any empirical work on micro data. See Larry Epstein (1992) for a discussion of these models.

TABLE 2.1  
STANDARD ADDITIVE MODEL SIMULATIONS

	$\varepsilon = 0$ $Y_1 = 1, Y_2 = 2$	$\varepsilon = 0.01$ $Y_1 = 2, Y_2 = 1$	$\varepsilon = 0.01$ $Y_1 = 1, Y_2 = 2$
First period consumption	1.5	1.49	0.98
Saving rate	-0.5	0.255	0.02
MPC from cash-on-hand	0.5	0.51	0.97
MPC from second period earnings	0.5	0.47	0.01
Discount rate for future expected earnings	0	2%	108%
Variance of second period log consumption	0	0.01	0.21

ity is quadratic (or that there is perfect certainty). We retain the assumptions of additivity over time for the utility function and of perfect capital markets. Because the latter implies that budgets are additive over time we call this less restrictive model the *standard additive model*.<sup>7</sup>

*Assumptions for the standard additive model.* Agents have intertemporally additive utility functions with a constant discount factor and face perfect capital markets. Agents maximize expected utility and form rational expectations.

The major difference between this model and the CEQ model is, of course, the allowance for nonquadratic preferences. This may not seem like much of a radical difference but it turns out that it is. One of the principal lessons that we have learned in the past decade is that the intuitions derived from the CEQ model can be highly misleading in the presence of even a small amount of uncertainty if agents display prudence (that is, the third derivative of the utility function is positive; see Miles Kimball 1990).

<sup>7</sup> Here we have introduced new nomenclature. Some investigators call this set of assumptions the "precautionary saving" model or the unwieldy "life-cycle model with additive preferences and perfect capital markets." We prefer our term to the former because the model allows for many other motives as well as the precautionary motive and it also maintains perfect capital markets which many "precautionary" models rule out.

To illustrate how misleading the CEQ model can be, consider the following simple two period model. Assume that the agent maximizes expected utility with lifetime preferences over the certain consumption path  $(C_1, C_2)$  represented by the utility function:

$$U(C_1, C_2) = \ln C_1 + \ln C_2.$$

Let  $Y_1$  be cash-on-hand (first period earnings plus any starting wealth) in period 1. Earnings in period 2 are stochastic; specifically, let second period earnings be zero with probability  $\varepsilon$  and  $Y_2/(1-\varepsilon)$  with probability  $(1-\varepsilon)$ . Thus an increase in  $\varepsilon$  represents a mean preserving spread in future earnings risk. Finally, we assume that the real rate of interest is zero.

In Table 2.1 we present some calculations for three different scenarios: perfect certainty ( $\varepsilon=0$ ) with low first period cash-on-hand and then uncertainty with high and low first period cash-on-hand respectively. We calculate first period consumption, the saving rate from first period income, the marginal propensities to consume (MPC) out of first and second period income, the effective discount rate used to discount future expected earnings (the discount rate for future expected earnings which would give the associated first period consumption if the agent had quadratic preferences), and the variance of second period log

consumption. The latter term will be discussed in the next subsection.

A number of features emerge from these calculations (see Stephen Zeldes 1989b; Kimball 1990; and Carroll 1992, 1993, for further discussion of these). First, the degree to which the CEQ model approximates the model with uncertainty depends on the time path of expected income. In particular, if first period cash-on-hand is low relative to second period expected earnings, then there can be wide divergences between the CEQ model and the additive model. In fact, in this example first period consumption can be discontinuous in  $\varepsilon$  at  $\varepsilon = 0$ ; this presents obvious problems for approximating consumption responses about the CEQ predictions. Second, with low first period income the MPC out of cash-on-hand can be close to unity even though there is "not much" uncertainty. Third, with low first period income the MPC out of future expected income can be close to zero. Thus the CEQ prediction that the MPCs out of current and future income are the same (in a world with independently distributed incomes, as here) is wildly wrong for some agents. Finally, even a small amount of uncertainty may be sufficient to stop the agent from borrowing in the first period.

Uncertainty also causes some agents to behave as though they discount expected future earnings at a higher rate than the market rate of interest. Whether or not agents do this depends critically on whether the agent would save or not in a CEQ world (which in turn depends on their current assets and the path of future income). In this example, future earnings are not discounted very much if CEQ saving would be positive (compare the final two columns of Table 2.1). This suggests that we cannot make a blanket prediction that uncertainty causes agents to discount future earnings with a rate

much higher than the real rate. Rather, the (implicit) discount rate will depend on the ratio of cash-on-hand to expected future earnings. Yet another feature of this example is that the precautionary motive gives rise to behavior that is very close to that generated by a CEQ model with a borrowing restriction; we shall discuss this further in the next subsection.

One other important feature of this example is also worth discussing at some length. The introduction of uncertainty in the final column of Table 2.1 leads to a considerable welfare loss. For this example, an agent with a certain income eight percent lower than the expected value of income would be just as well off.<sup>8</sup> Thus there is considerable scope for insurance here because the actuarially fair premium would be only two-thirds of a percent of expected lifetime income. If outcomes are independent across many agents then the introduction of a social insurance scheme would lead to a considerable welfare gain for society. This is, of course, the traditional rationale for a government unemployment insurance scheme (see Martin Baily, 1978, for further discussion of the tradeoff between these gains and moral hazard losses). If a social insurance scheme is introduced here it raises welfare but it also lowers saving considerably. From Column 3 of Table 2.1, a fully insured agent will now borrow an amount equal to a little over one half of first period income rather than saving a small amount. Of course the numbers given here are rather extreme but the basic point is valid: the introduction of a precautionary motive leads to a rationale for social insurance and the introduction of the latter leads to a consequent attenuation of the precautionary motive.

<sup>8</sup> This figure of 8% is only illustrative. It would be higher for a higher coefficient of relative risk aversion and lower if there are many periods so that agents could smooth shocks over time.

In this example some agents (those with low first period cash-on-hand) have responses that are “Keynesian” even though the framework is a standard additive one (see also Robert Barsky, N. Gregory Mankiw, and Zeldes 1986). Note, however, that although agents are free to borrow or lend in this example, there is still an important missing market, viz., insurance against the catastrophic income outcome. If moral hazard and adverse selection problems can be overcome or if someone (family, friends, or the government, for example) provides a floor to consumption even in the event of bankruptcy then agents may borrow in the first period. However, the main point carries over: the CEQ model may be a very unreliable guide to saving behavior for agents who have a precautionary motive.

### 2.3 *The Euler Equation for Intertemporal Allocation*

Most recent empirical work on saving and consumption employs the optimality condition (or Euler equation) implied by the standard additive model as a starting point. Thus, we turn now to the derivation of this Euler equation for consumption. We denote the within period utility function by  $v(C, \mathbf{Z})$  where  $C$  is consumption<sup>9</sup> and  $\mathbf{Z}$  is a vector of modifiers for utility which we shall refer to as “demographics.” The usual candidates for inclusion in  $\mathbf{Z}$  are household composition, health status, and labor supply but it can be anything that affects household utility. The discount factor is denoted  $\beta$ ; it is usually taken to be less than unity. Given the standard additive model assumptions we can use standard variational methods to derive the *Euler equation* for optimal allocation between periods  $t$  and  $t + 1$ :

<sup>9</sup> See Browning (1989a) for the extension to a many good framework.

$$v_C(C_t, \mathbf{Z}_t) = E_t \{ \beta(1 + \tilde{r}_t) v_C(\tilde{C}_{t+1}, \tilde{\mathbf{Z}}_{t+1}) \} \quad (2.1)$$

where  $r_t$  is the real rate between the two periods; the  $\tilde{\cdot}$ s denote that the variable is stochastic and  $v_C(\cdot)$  is the partial of  $v(\cdot)$  with respect to  $C$ . This Euler equation encapsulates the central insight of the standard consumption model, viz. that agents try to keep the marginal (discounted by  $\beta$ ) utility of (discounted by  $r$ ) expenditure constant over time. As we shall see in Section 5, the Euler equation (2.1) has been the focus of most empirical work on consumption since its use in Robert Hall (1978). The reason for this is that, to estimate the parameters of the utility function  $v(C, \mathbf{Z})$ , we need to observe consumption only in two different periods, as well as observing interest rates and demographics; we do not need to observe wealth or model agents' expectations. By 1978 the need for the latter was increasingly the stumbling block in applying life-cycle ideas to the empirical analysis of consumption and saving behavior. For empirical and theoretical work we typically need a parameterization for the utility function.<sup>10</sup> Other than the quadratic form, the most widely used is the Constant Relative Risk Aversion (CRRA) or iso-elastic utility function:

$$v(C, \mathbf{Z}) = \frac{1}{1 - \gamma(\mathbf{Z})} \left\{ \frac{C}{\alpha(\mathbf{Z})} \right\}^{1 - \gamma(\mathbf{Z})} \quad (2.2)$$

The appeal of the iso-elastic form is not in its tractability (as we shall see it is not particularly easy to manipulate) but in its a priori plausibility. Both Friedman (1957) and Modigliani and Brumberg (1954) defend the assumption that intertemporal preferences over certain outcomes are homothetic; that is, a ten percent increase in lifetime wealth (or

<sup>10</sup> See Browning (1989b) for nonparametric (revealed preference) conditions.

permanent income) will lead to a ten percent increase in expenditure in each period. The implication of this "proportionality" assumption is that in a perfectly certain world, consumption in any period is proportional to lifetime wealth. The actual proportion depends on discount factors, interest rates, the length of remaining life, and demographics but not the wealth level itself. The other assumption used widely in the consumption literature is that utility is additive over time. Combining homotheticity with intertemporal additivity gives the iso-elastic form, hence its popularity.

The "parameter"  $\gamma(\mathbf{Z})$  is the coefficient of relative risk aversion; by definition it is independent of the level of lifetime wealth but not necessarily of demographics. Concavity requires that  $\gamma$  be positive. The function  $\alpha(\mathbf{Z})$  is effectively an adult equivalence scale; usually we require that the marginal utility of consumption be increasing in, say, family size.

We now derive the Euler equation for the iso-elastic utility function. To simplify notation we shall assume that  $\gamma(\cdot)$  is independent of demographics. From the Euler equation (2.1) we have:

$$\beta(1+r_t) \left\{ \frac{\alpha(\mathbf{Z}_{t+1})}{\alpha(\mathbf{Z}_t)} \right\}^{\gamma-1} \left\{ \frac{C_{t+1}}{C_t} \right\}^{-\gamma} = 1 + e_{t+1} \text{ with } E_t(e_{t+1}) = 0. \quad (2.3)$$

Let the variance of  $e_{t+1}$  conditional on information available at time  $t$  (that is, the expected variance) be given by  $\sigma_{t+1}^2$ ; we refer to this as the consumption shock variance. To simplify we take  $\mathbf{Z}$  to be a scalar and parameterize  $\alpha(\mathbf{Z}) = \exp(\alpha\mathbf{Z})$  where  $\alpha$  is now a parameter. Taking logs and using the usual approximation for logs<sup>11</sup> we have the linearized Euler equation:

<sup>11</sup> An alternative is to assume that  $1 + e_{t+1}$  is log-normally distributed in which case the approximation we shall give is exact.

$$\Delta \ln C_{t+1} = \tilde{\beta} + \tilde{\alpha} \Delta \mathbf{Z}_{t+1} + \phi r_t + 0.5 \phi \sigma_{t+1}^2 + u_{t+1} \quad (2.4)$$

where  $\phi = 1/\gamma (> 0)$ ,

$$\tilde{\beta} = \phi \ln(\beta),$$

$$\tilde{\alpha} = \alpha(\gamma - 1)/\gamma$$

and  $u_{t+1} = -\phi(e_{t+1} - 0.5(e_{t+1}^2, -\sigma_{t+1}^2))$

so that  $E_t(u_{t+1}) = 0$ .

Before considering this equation in detail, it is worth noting that it captures in a parsimonious and simple way several of the motives listed at the beginning of this survey. Thus the life-cycle motive is given by the changes in circumstances implicit in the  $\Delta \mathbf{Z}$  variables. The intertemporal substitution and precautionary motives are given by the next two terms respectively. The bequest motive is also present but implicit because it affects the level of consumption and not first differences. In the next subsection we shall see that we can also include habits, liquidity constraints, and the downpayment motive. Thus this equation is a potentially powerful way of organizing our thoughts about consumption paths.

Let us consider the right hand side of (2.4) term by term. The first term is a discount factor; a lower  $\beta$  can be thought of as higher impatience which leads to higher consumption in early periods and hence lower saving and consumption growth. The second term allows for the influence of anticipated changes in demographics on consumption. Although these demographic terms are largely ignored in the aggregate time series literature (for the good reason that they change only very gradually in the aggregate) they are potentially important sources of variation in consumption at the micro level.

The coefficient on the interest rate,  $\phi$ , gives the response to the anticipated real rate. Thus it is the proportional change in consumption consequent on an anticipated one percent change in the discounted price of consumption (which

equals the real rate of interest). For this reason  $-\phi$  is known as the intertemporal substitution elasticity. Here “anticipated” means “keeping the marginal utility of expenditure constant” so that this price response is a (Frisch) compensated response and can be signed from the theory: the coefficient  $\phi$  should be positive. This restriction is the only integrability condition that the (one good) Euler equation has to satisfy.

The time discounting, demographic, and interest rate effects are all present in the CEQ model but the fourth term on the right hand side of (2.4) is absent from that model. The term for the consumption shock variance captures the precautionary motive. If the variance of future consumption increases then agents save more for the future and (expected) consumption growth increases. This follows because higher uncertainty leads agents to lower the level of current period consumption in order to increase (precautionary) saving. Because the intertemporal budget constraint is unchanged this leads to higher consumption later (on average).

In equation (2.4) there is a close link between intertemporal substitution and prudence (the coefficient on  $r_t$  is twice that on  $\sigma_{t+1}^2$ ). This is accidental to the CRRA case; it follows because we have only one parameter in the utility function so this must control both prudence and intertemporal substitution.<sup>12</sup> In general there is no necessary link between risk aversion and prudence. Indeed, risk averse agents ( $v_{CC} < 0$ ) can display im-

prudence ( $v_{CCC} < 0$ ). Although Marshall found this the more compelling case, most modern authors have taken it as a given that agents are not imprudent (that is,  $v_{CCC} \geq 0$ ). Kimball (1990) provides a thorough discussion of prudence and its links with risk aversion and the precautionary motive.

The variance term in (2.4) has been the focus of a great deal of recent attention. We shall return to this in the empirical section; for now we note two of the most important features of precautionary saving. The first is that it obviously depends on the uncertainty associated with future exogenous variables. For example, agents who have higher variance in future income will have higher saving. Also agents who face higher uncertainty about future demographics will change their saving behavior. For example, if demographics include ill health (and agents do not have full medical insurance) then saving will reflect changes in the probabilities of ill health, over and above the induced changes in the distribution of future earnings.

The second important feature of precautionary saving is that it depends on cash-on-hand (assets plus current earnings). To illustrate this, consider again the two period model developed earlier. In the last row of Table 2.1 we presented the variances of second period log consumption. The important point here is that this variance is about 20 times higher for the case in which first period cash-on-hand is low relative to expected lifetime income. Moreover, this very large difference is not being driven by differences in income risk: for both cases the second period income process is the same. Thus future income variance is not, by itself, an adequate proxy for the variance term in (2.4); how this risk impacts on current consumption decisions depends on the level of current assets

<sup>12</sup>There is a related issue here which is distinct from the point being made in the text. In any expected utility model that assumes additivity over time there is also a necessary link between intertemporal substitution and risk aversion—agents will be not be very responsive to (anticipated) changes in the real rate if and only if they are risk averse (see Deaton, 1992, for an accessible account and Epstein, 1992, for a full discussion). This will be the case for any utility function.



and income relative to expected future income.

To investigate these issues more deeply we need to move beyond the Euler equation and consider consumption functions. Even consideration of the simple two period model yields the important theoretical point that the non-CEQ additive model does not imply that agents who expect high future incomes (for example, students in medical school) will necessarily borrow to finance consumption in their early years. This is the case even if agents have access to perfect capital markets. While it is useful to have simple analytical counter-examples, to actually generate predictions in more realistic environments it is necessary to consider many period models.

If we wish to analyze many period non-CEQ models then we must have recourse either to approximations (see, for example, Skinner 1988; or John Campbell and Mankiw 1989), to the CARA utility form (Ricardo Caballero 1990, 1991), or to simulations. An older example of a simulation that takes explicit account of the effect of the precautionary motive is given in Keizo Nagatani (1972). Nagatani assumes that agents have discount rates that are a good deal higher than the real interest rate and that there is consumption growth in the pre-retirement period. Even though Nagatani's theoretical analysis now looks decidedly dated his simulations bring out many of key features that emerged in the later debate. For example, the need for high discount rates (or, more generally, some form of "impatience") and uncertainty to reconcile the standard additive model with the observed coincidence of income and consumption in the early part of the life cycle; the interaction between the effects of uncertainty and the ratio of human to nonhuman wealth and the difference between the marginal propensities

to consume out of the two types of wealth.

More recently, a number of authors have taken simulations much further (see, for example, Zeldes 1989b; Deaton 1991; Carroll 1993; Orazio Attanasio et al. 1995; and Glenn Hubbard, Skinner, and Zeldes 1994a, 1995). We shall return to some of these analyses in the next section when we consider liquidity constraints but for the standard case without liquidity constraints, Carroll (1993) and Attanasio et al. (1995) provide insights. Carroll shows that for particular income processes, if we have a precautionary motive and "impatience" (the precise definition of which will depend on the context) then consumption "tracks" income in the early part of life; effectively, it is only in later years (say, after age 45) that we observe significant saving. In the Carroll model it is the possibility of destitution in later periods that stops agents from borrowing in earlier years. This leads to "buffer stock" behavior: agents have some (typically quite small) wealth/income ratio target. If wealth is below this then prudence dominates and the agent tries to save; above the desired ratio, impatience leads agents to run down their assets.

Attanasio et al. (1995) allow for demographics and show that we can even do without impatience: the fact that children "arrive" early in life is enough to induce a strong correlation between consumption and anticipated income in the early part of life (see also James Tobin 1967). However, children alone are not enough to reproduce the typical lifetime paths of income and consumption; a precautionary motive is also necessary. This analysis takes the time paths of income and children as given. It would be extremely interesting to extend these studies of the standard additive model to allow for the fact that, to a certain extent, agents choose the time profile and risk-

ness of income and also the time path of demographics. Thus high education agents marry later and start their families later which may be connected to their income processes.

Summing up for the model that allows for a precautionary motive, we can state that the most important conclusion that arises from recent theoretical work on consumption and saving is that this model is much less restrictive than the widely used CEQ model. It is also the case that the implications of the CEQ model may be a very misleading guide to what to expect from a precautionary saving model. This increased flexibility is both good news and bad news. The good news is that the standard additive model is a good deal less restrictive than is widely thought and is compatible with a much richer variety of short-run and lifetime consumption patterns than is suggested by the CEQ model. The bad news is simply the converse of this. Even if the assumptions of the standard additive model hold, it has far less predictive power than the CEQ model so that estimation of the parameters of the model assumes a greater importance. All of this assumes, of course, that the standard additive model is valid for all agents; this is by no means universally accepted because the assumptions that underpin it are questionable. We turn now to a consideration of relaxing some of these assumptions.

## 2.4 *Liquidity Constraints and Habits*

Of all of the assumptions of the standard additive model, the one that has been most questioned is the existence of perfect capital markets (see Fumio Hayashi 1987 and Deaton 1992). This is usually taken to mean that there is a single rate of interest at which agents can borrow or lend as much as they wish. This is palpably not the case. First, most

agents seem to employ a variety of different borrowing and lending instruments at the same time so that “the” interest rate any agent faces (in the sense of how much extra consumption could be enjoyed next year if one dollar of consumption is given up this year) is not always well defined, much less observable by a researcher. It is also the case that borrowing rates typically exceed lending rates and that people often ask for credit and are refused.

To allow us to capture the essence of the effects of liquidity constraints we shall adopt a few simplifying assumptions. First we shall assume that interest rates are constant and are known when consumption in time  $t$  is chosen. Second we shall assume that there are two rates, one for borrowing ( $= r_B$ ) and one for lending ( $= r_L$ ) with  $r_L > r_L$ .<sup>13</sup> This includes the special case for which  $r_B = +\infty$ ; that is, assets are constrained to be non-negative.

We begin with the very obvious point that liquidity constraints are likely to be of interest only for agents who want to borrow. This has led to investigators concentrating on the case where either there is some income growth or agents have high time discount factors or the “consumption needs” captured by the demographic variable occur early in the life cycle. Note that the presence of any (or even all) of these is not sufficient to ensure that agents will want to borrow but some such assumptions seem to be necessary. With different borrowing and lending rates, the revised version of (2.1) is given by:

$$v_C(C_t, \mathbf{Z}_t) = \beta(1 + r_V)E_t v_C(\tilde{C}_{t+1}, \tilde{\mathbf{Z}}_{t+1}) \quad (2.5)$$

<sup>13</sup> If we allow for uncertain interest rates then we need to assume that there is zero probability that the realized lending real rate exceeds the realized borrowing real rate (see Browning and Leslie Robb 1985).

where  $r_V$  is the “virtual” interest rate used for optimal intertemporal allocation. Thus  $r_V$  is defined to be the real rate that ensures that the Euler equation holds. It is the lending rate for lenders, the borrowing rate for borrowers, and some intermediate rate for those who do not carry forward assets or debt from period  $t$ . Note that even if assets are constrained to be non-negative (formally,  $r_B = +\infty$ )  $r_V$  will still be finite.

Suppose now that we do not observe the interest rate implicitly used by the agent but only the lending rate. This gives:

$$v_C(C_t, \mathbf{Z}_t) \geq \beta(1 + r_L)E_t v_C(\tilde{C}_{t+1}, \tilde{\mathbf{Z}}_{t+1}) \quad (2.6)$$

with equality if the agent is a lender. Thus in expectation, the marginal utility of expenditure using the lending rate to discount is nonincreasing rather than constant. This can be rewritten in more familiar Lagrange multiplier form as:

$$v_C(C_t, \mathbf{Z}_t) = \beta(1 + r_L)(1 + \psi_t)E_t v_C(\tilde{C}_{t+1}, \tilde{\mathbf{Z}}_{t+1}) \quad (2.7)$$

where  $\psi_t \geq 0$  and  $\psi_t A_{t+1} \leq 0$  (where  $A_{t+1}$  is the level of assets carried forward from period  $t$  to  $t + 1$ ). The value of  $\psi$  is  $(r_V - r_L)/(1 + r_L)$ ; because  $r_V \geq r_L$  this is automatically non-negative and attains its maximum at  $r_V = r_B$ .

We can incorporate this into the Euler equation for the iso-elastic case:

$$\Delta \ln C_{t+1} = \tilde{\beta} + \alpha \Delta \mathbf{Z}_{t+1} + \phi r_L + 0.5 \phi \sigma_{t+1}^2 + \phi \ln(1 + \psi_t) + u_{t+1}. \quad (2.8)$$

Thus consumption growth between  $t$  and  $t + 1$  is higher for liquidity constrained agents than for those who carry forward some assets (see Zeldes 1989a; and Deaton 1992). That liquidity constrained agents will consume less in the current period than they would like is almost tautologous; it hardly requires (2.8) to

show this. There are, however, more interesting implications.

One trivial consequence of liquidity constraints is that if zero assets are carried forward for many periods then consumption changes will be set equal to (earned) income changes over this period. In these periods, the Euler equation (2.1) will not hold if we use the lending rate to discount future values. Instead the agent will appear to be a “rule of thumb” agent who simply sets consumption equal to income. There is, however, one critical difference between the behavior of a liquidity constrained agent and one who sets income equal to consumption in each period. For the former, we may observe periods in which the agent saves and hence periods in which consumption is either lower or higher than earnings. This asymmetry and the consequent difference from “rule of thumb” behavior will be explored in Section 5.

The behavior of a liquidity constrained agent may also be similar to an agent who can borrow as much as desired but who has a significant precautionary motive (see Carroll 1993). In equation (2.8), the effects of increased uncertainty (higher  $\sigma^2$ ) and the effects of a more tightly binding liquidity constraint (higher  $\psi$ ) are identical. Moreover, current cash-on-hand is negatively correlated with both variables. It is also the case that the marginal propensities to consume out of current and future income are similar for both types of agent. Thus it may be very difficult to empirically distinguish the effects of liquidity constraints and a strong precautionary motive.

There is another important effect of liquidity constraints that we can see operating in (2.8) (see Deaton 1991). Even for an agent who is not liquidity constrained between periods  $t$  and  $t + 1$ , the variance term  $\sigma_{t+1}^2$  may be larger be-

cause of possible liquidity constraints between periods  $t + 1$  and  $t + 2$ . This follows because the possibility of borrowing provides some insurance; agents who are not liquidity constrained can tide themselves over runs of bad luck by borrowing against future income. If this option is removed then the variance of future consumption is increased. Thus the mere possibility of being constrained in the future may increase consumption growth for agents even if, *ex post*, they are never actually observed to be constrained (for example, even if they always carry forward positive assets).

The possibility of future liquidity constraints also has another implication for intertemporal allocation. This effect derives from the budget constraint. Suppose that at time  $t$  the agent knows that they will be constrained between periods  $t + s$  and  $t + s + 1$  so that  $A_{t+s+1} = 0$ . Then the budget constraint between periods  $t$  and  $t + s$  depends only on assets at time  $t$  and earnings in periods  $t$  to  $t + s$ . Thus it is as though the agent acts with a short time horizon (here equal to  $s + 1$  periods); the presence of possible future liquidity constraints may lead agents to behave as though they are less forward looking than is suggested by the standard additive model. Once again, the role of family composition may be critical. If consumption "needs" peak when there are older children in the home and households are liquidity constrained, then it may be that saving "for retirement" begins only when children leave home.

This distinction between long-run and short-run behavior is potentially important. As we have stressed above, one of the most remarkable features of the standard consumption model is that it gives predictions for both the short run and the long run. In a model without liquidity constraints, agents set current consumption to equalize the current and ex-

pected next period marginal utility of expenditure but they also set this level to equalize the expected marginal utility of expenditure in the distant future. The presence of liquidity constraints may break the link between long-run and short-run behavior. Thus we may observe agents smoothing over the short run but not over the long run.

We now turn to other features of the consumption function with liquidity constraints. Once we include even highly stylized representations for real needs or constraints then we have to resort to simulations to recover the consumption function. Here we present some of the main results from Deaton (1991) and Hubbard, Skinner, and Zeldes (1994a, 1995).

Deaton (1991) presents results for infinitely lived, liquidity constrained agents who face both stationary and non-stationary earnings processes (see also Deaton 1992, section 6.2). Assuming impatience, which in this context means choosing parameters so that agents would "typically want to borrow," Deaton uses numerical techniques to derive the consumption function for various income processes. For the i.i.d. income case the consumption function is particularly simple. To a close approximation, consumption is set equal to cash-on-hand (current income plus assets) if the latter is below mean income; otherwise consumption is set equal to mean income plus some fraction of cash-on-hand above mean income (the fraction is 0.3 in the case Deaton examines). Deaton calls such behavior "buffer stock" behavior because agents accumulate assets only to insulate themselves from income fluctuations. One of the most interesting features of these results is that even small levels of assets can achieve considerable smoothing of consumption. For the i.i.d. case, mean assets are equal to one month's income but the standard de-

viation of consumption is only half of that of income. As we introduce more persistence into income, however, agents achieve less smoothing and as income approaches a random walk the variance of consumption tends to that of income.

Hubbard, Skinner, and Zeldes (1994a, 1995), in what is certainly the richest set of simulation studies attempted to date, consider liquidity constrained agents in an environment with a number of sources of uncertainty. Specifically, they allow for uncertainty over earnings (including unemployment insurance benefits), medical expenses (which are highly persistent), and the length of life. Earlier studies typically focused on only one source of risk. In the Hubbard, Skinner, and Zeldes simulations there is no bequest motive; earnings are exogenous (so the retirement date is given and is independent of the state of health); and the government provides a low consumption floor (\$7,000 in their benchmark model). The richness of the environment that Hubbard, Skinner, and Zeldes consider brings out the importance of institutional factors such as unemployment and medical insurance schemes.

One of the most important features that Hubbard, Skinner, and Zeldes incorporate into their simulations is the presence of an assets test for medical and income support benefits. This leads to a nonconvexity in the environment which induces many agents to rationally hold very low levels of assets. They compare their benchmark model (which has moderate rates of time discounting) with a liquidity constrained CEQ model and what they term a buffer stock model (high discount rates and a low consumption floor). In general the predictions of the three sets of models are quite different; we shall discuss the comparisons of these predictions with the data in a later section. We note, however, that Hubbard, Skinner, and Zeldes (1994a, 1995)

do not present simulations for a model with perfect capital markets so that it is difficult to isolate exactly the differences made by allowing for a precautionary motive.

The second generalization of the additive model that we consider is to allow for nonadditive utility functions. Even leaving aside durables, the incorporation of some dependence of current tastes on past consumption has long been thought desirable. For example, some notion that consumption is "habit forming" implicitly underlies Keynes' "improvement" motive (motive 4 in the list at the beginning of the paper). In such models, upward changes in consumption have a smaller utility effect than similar downward ones so that agents will not want to start off with high levels of consumption.

The analysis of temporal dependencies in preferences has a long history, see Browning (1991) for further discussion and references. Essentially two different models have been used almost exclusively in the consumption literature. The first of these is the "habits-as-durables" model in which the effects of past consumption are captured in a (psychological) stock of habits which increases the current marginal utility of consumption. The other model is the "short memory" model in which only last period consumption matters. These models are used because the effect of the past is captured by a single state variable (the stock of habits and last period consumption, respectively). We refer the reader to Deaton (1992) for further discussion of nonadditive preferences; here we simply remark that their introduction into the model further weakens the possibility of deriving simple testable implications from the standard consumption model.

In practice there are very many goods, some durable or satiating, some habit

forming, and some nondurable. It is our belief that ultimately an adequate understanding of consumption and saving patterns will require a recognition that there are many goods and some of these are durable and that even the nondurables may be satiating or habit forming. For example, Browning and Thomas Crossley (1995) suggest that agents smooth welfare levels over an unemployment spell by postponing the purchase of small durables and clothing. This leads to a sizable change in total expenditure levels but a much less significant change in utility levels because the service flows from old durables do not change significantly during an unemployment spell. Thus agents can smooth by having recourse to "internal" capital markets even if they are formally liquidity constrained.

In this section we have reviewed some of the recent developments in the theory of intertemporal allocation. As we have seen, the past decade has seen an intensive investigation of several alternatives to the traditional CEQ model. One strand of this, which we call the standard additive model, retains the assumptions of the CEQ model concerning time-additive preferences and the existence of perfect capital markets but allows for precautionary saving. Perhaps surprisingly, this apparently modest increase in generality admits a much wider range of predictions, particularly when we have some latitude in the income process that we impute to agents. We have shown how different the predictions of the standard additive model can be from the CEQ model and we emphasize again that the latter may not be a good "benchmark" for the non-CEQ model. This is not to say that the CEQ model is wrong, simply that it is far more restrictive than was previously thought. The other generalizations include allowing for liquidity constraints and for habits, satiation, and durability. Which of these extensions (if

any) is the most fruitful is an empirical matter.

The different hypotheses given above have different implications for consumption and saving. One way to test between these hypotheses is by formal testing; we shall return to this in Section 5 below. Another approach is to see how well the various theories "fit" the facts. For example, most standard models predict that old people should dissave. It seems a straightforward question to ask whether they typically do. To do this fitting of facts, we first need to agree on what the facts are. It is to this that we now turn.

### 3. *Facts on Household Saving*

#### 3.1 *Saving: Data Sets and Measurement Issues*

We begin with a summary of the data sets that allow us to examine the micro facts concerning household saving in the U.S. In Table 3.1 we list eight different sources that can be used to look at saving behavior at the micro level; many of these can also be used to examine wealth. As can be seen from Table 3.1 there are a variety of sources covering different periods and different groups. For example, the HRS, the AHEAD, and the RHS data sets allow us to study the saving behavior of the elderly, while the other data sets consider the entire population. The SCF has the advantage of oversampling the rich households, who, as we will see below, do most of the saving.

To define saving we take the usual budget condition for financial assets:

$$A_{t+1} = (1 + r)A_t + Y_t - C_t \quad (3.1)$$

where  $A$ ,  $r$ ,  $Y$ , and  $C$  are financial assets, the real rate, earnings, and consumption, respectively. We can define saving as the first difference of assets ( $= A_{t+1} - A_t$ ) or, equivalently, as (earned plus capital) income minus consumption ( $= rA_t + Y_t -$

TABLE 3.1  
U.S. DATA SETS FOR SAVING

Data Set	Period	Definition of Saving	Major Features
Survey of Consumer Finances (SCF)	1962/63;1983/86/89;1992	First difference of wealth (Direct measure in 1992)	Big attrition. Oversampling of rich. Pension provider surveys.
Consumer Expenditure Survey (CES)	1960/61; 1972/73 1980-present	Income minus consumption	Measurement error in income.
Panel Study of Income Dynamics (PSID)	1968-present	First difference of wealth 1984/89	Active and passive saving.
Health and Retirement Survey (HRS)	1992-present	First difference of wealth	Only older respondents. Pension provider surveys.
Asset and Health Dynamics Survey (AHEAD)	1993-present	First difference of wealth	Only very older respondents.
Survey of Income and Program Participation (SIPP)	1984-present	First difference of wealth	Overlapping panels. Only some components of wealth.
National Longitudinal Survey (NLS)	Various, depending on survey	First difference of wealth	Various specific cohorts followed.
Longitudinal Retirement History Survey (RHS)	1969-79 bi-annual	First difference of wealth	Aged 58-63 in 1969.

$C_t$ ). At the aggregate level, saving has been measured in these two ways: from the National Income and Product Accounts (NIPA) as the difference between personal outlays and disposable personal income and from the Flow of Funds (FOF) of the Federal Reserve System as the household sector's net acquisition of assets (including housing) minus its net accumulation of liabilities (see John Wilson et al., 1989, for an analysis of the discrepancies between the NIPA and FOF measures of saving). These simple schemes are not without difficulties which ultimately derive from the fact that we can have different measures of saving for different purposes. For example, the NIPA definition gives a very precise measure of the flow of funds by households that are available for investment. This may differ from, say, saving for retirement as perceived by households.

One problem with the NIPA definition

is that it includes the purchase of durables in consumption which implicitly assumes that such goods are consumed at once even though they are best thought of as additions to the stock of durables. An additional problem for the "income minus consumption" definition is that contributions to funded government retirement plans are not included in personal income and are thus not included in saving. Even more bothersome is the fact that changes in inflation change the level of saving as measured by the NIPA definition. In an inflationary period, nominal interest rates incorporate the expectations of net capital losses on fixed dollar financial assets. One therefore has to account for the fact that higher interest rates are just the compensation for capital losses. Without adjustment, an increase in inflation causes the saving rate, as measured in the NIPA, to rise (see Patric Hendershott and Joe Peek 1989).

It will be clear, then, that even at the

aggregate level there are difficult problems in defining "household sector" saving. These problems do not dissolve when we move to the individual household level. At this level, we can obviously use either of the two definitions of saving: income minus consumption or first differences of wealth. But which measure of consumption, income, and wealth should we take? We have already discussed some of the problems with the former two. As for wealth, as already mentioned there is no "correct" definition of wealth but rather measures that are more or less useful for different purposes. The only circumstance under which one could define wealth in a universally applicable way would be if the CEQ assumptions outlined in the previous section held. In that case expected future receipts (irrespective of their riskiness and liquidity) have the same impact on current decisions as currently held liquid assets. In general, however, the riskiness and fungibility of different assets and liabilities has an effect and this leads to ambiguity about which measure of wealth is useful in any particular application. Thus it may be useful in some contexts to include a measure of, say, "pension wealth" while in other circumstances we may even want to exclude the current stock of durables.

However we define saving at the household level we need to make adjustments to reconcile these values with aggregate numbers. Partly this is because micro data does not provide the same information as aggregate statistics. Also, the change in net worth of the household sector differs from the NIPA and FOF measure of saving because those two measures ignore the effects of changes in the prices of assets already in the portfolios of the household sector. A final problem with the micro data is the noisiness of the saving data at the household level (see, for example, Robert Avery

and Kennickell 1991; Barry Bosworth, Gary Burtless, and Sabelhaus 1991; Attanasio 1993; and Alessie, Lusardi, and Trea Aldershof 1994). Differencing an already noisy series (wealth) can lead to very high (and spurious) variability in the saving level.

There is also a more prosaic reason why the aggregate and micro saving rates may not coincide: the aggregate saving rate is the ratio of two means which will not generally equal the mean of saving to income at the micro level. That is, the aggregate saving rate and the average saving rate can be different even if based on exactly the same definitions. To illustrate that this difference may be significant, suppose that log income is normally distributed and that saving is a piecewise linear function of income. Specifically, let saving be zero for households with below median income. For households in the top half of the income distribution, let saving be 30 percent of any income above median income.<sup>14</sup> If log income has a mean of zero and a standard deviation of unity then simple simulations give that the aggregate saving rate is 16 percent while the average (micro) saving rate is only seven percent (and the median saving rate is zero!). This should always be kept in mind when comparing aggregate saving rates with the average rates given below.

### 3.2 Household Saving: The Facts

We present here some facts about household saving in the U.S. We examine the behavior of saving across age, family composition, income, education, and wealth groups. Note that these are all simple bivariate analyses; conclusions that are drawn may not necessarily hold in a multivariate framework. Before turning to the distribution of saving

<sup>14</sup> This saving function is suggested by the simulations in Deaton (1991).



TABLE 3.2  
SAVING RATES (%), BY AGE

Age	25–34	35–44	45–54	55–64	65 +
Saving ratio 1972/73	9.5	12.1	16.8	22.9	14.9
Saving ratio 1982/85	9.6	8.6	10.5	15.8	11.5

Source: Bosworth, Burtless, and Sabelhaus (1991, table 3. Data set: CES). Saving equals income minus consumption.

across age groups we should first note that people and not households have ages. It is important to bear in mind that different members of the household may have very different saving propensities. In particular, if young people stay at home and accumulate savings, this will be attributed to their parents in the following calculations. As to the facts: both Avery and Kennickell (1991) (who derive saving from first differencing wealth) and Bosworth, Burtless, and Sabelhaus (1991) (who derive saving both from differencing wealth and from income minus consumption) show that saving is positive for every age group. As can be seen from Table 3.2, mean saving rates increase until the period around retirement and then decrease. The other obvious feature of this table is that saving rates declined between 1973 and 1983 for all of the over-35 age groups. In Table 3.3 we see that mean saving levels are a good deal higher than median levels which simply reflects the fact that saving levels are right skewed. The other obvious feature of Tables 3.2 and 3.3 is that saving appears to increase until the mid or late 60s. Finally, note that the median level of saving is quite low; indeed, a great many households make no saving at all.

Another demographic factor which is important for saving behavior is the composition of the household. Looking at saving across household types, saving rates are higher for married couples with no children and lower for households

with children, while lone parents have the lowest saving rate in the population (see Bosworth, Burtless, and Sabelhaus 1991; and Avery and Kennickell 1991). James Smith (1994), who defines saving by first differencing wealth in the PSID waves in 1984 and 1989, finds evidence of a relationship between saving and marriage. Households who were continuously married enjoyed a large increase in assets of 7.1 percent per year. In contrast, asset growth for households who never remarried was half as large and was negative among widowed and separated families. Income disparities among alternative household configurations do not seem to account for all of these differences.

The distribution of saving across income groups shows a very strong positive relationship between income and saving. In particular, a large proportion of total saving is due to families in the top part of the income distribution. According to Avery and Kennickell (1991), an overwhelming proportion of total saving is due to the top income decile of families. The same finding is reproduced in Bosworth, Burtless, and Sabelhaus (1991). They find that saving is usually negative for the first and second income quintile and highest in the top quintile.

Some of the observed correlation between income and saving is attributable to measurement error in income if saving is defined as income minus consumption. In addition, any consumption smoothing

TABLE 3.3  
(THREE YEAR) SAVING LEVELS, BY AGE

Age	20-34	35-44	45-54	55-64	65-69	Over 70
Mean Saving	13,300	14,800	18,700	22,400	30,500	1,400
Median Saving	2,400	3,200	4,200	500	500	-500

Source: Avery and Kennickell (1991, table 7. Data set: SCF). Saving equals 1986 wealth minus 1983 wealth. All values in 1986 dollars.

story will give a positive correlation between current income and saving because transitory income shocks will lead to higher current income and to more saving. It seems unlikely to us, however, that these are the main factors in the positive correlation between income and saving. There is far more cross-section variation in income than there is measurement error or "within" variation from year to year for most agents. If this is the case, then the observed positive correlation is due to genuine permanent differences in saving behavior. This can be checked by looking at indicators for "permanent" income, for example, education.

Given the correlation between income and education, it will come as no surprise that the distribution of saving across education groups also shows a distinct pattern of higher saving for higher education groups (see Avery and Kennickell 1991; Douglas Bernheim and Scholz 1993; and Attanasio 1993). Attanasio (1993) takes account of cohorts when examining saving across education groups and shows that the age profile of saving is hump-shaped for each education group, but especially for highly educated households. There is nothing in our theory models to predict that low education group, should have low saving rates and some studies have indicated that households without a college degree tend to save very little, possibly "too" little (see Bernheim and Scholz 1993).

Saving is also very concentrated in the

top part of the wealth distribution in the U.S. Avery and Kennickell (1991) record that almost all of the net saving between 1983 and 1986 was made by the top decile of the 1986 wealth distribution. Although some of this is spurious (because saving is defined as the difference between wealth in 1986 and 1983) it clearly reflects the importance of the rich in the saving distribution. Note also that there have been sharp changes in the wealth distribution per se, and the 1980s witnessed an increase in inequality in the wealth distribution (see Edward Wolff 1994). Finally, we simply note that saving is typically higher for homeowners and among those who hold stocks and bonds (see Bosworth, Burtless, and Sabelhaus 1991; and Avery and Kennickell 1991).

The picture that emerges from these facts is that saving is concentrated among those with high income/wealth/education. These findings pose some problems for theory. These include: why do so many households save so little? What motivates the saving behavior of the wealthy? In addition we could ask: is the saving behavior of the elderly consistent with any standard model?

#### 4. *The Decline in the U.S. Saving Rate*

##### 4.1 *Evidence on the Decline in the Saving Rate*

As seen in Table 3.2, saving rates seem to have declined sharply in the U.S. in

TABLE 4.1  
AGGREGATE SAVING RATES, 1970–1990

Year	"Revised" Figures	"Old" Figures
1970–74 (AVERAGE)	8.2	8.5
1975–79 (AVERAGE)	7.3	7.5
1980	7.9	7.1
1981	8.8	7.5
1982	8.6	6.8
1983	6.8	5.4
1984	8.0	6.1
1985	6.4	4.5
1986	6.0	4.3
1987	4.3	3.8
1988	4.4	—
1989	4.0	—
1990	4.2	—

Source: Economic Report of the President. 1988 for "old" figures and 1995 for "revised" figures.

the recent past. This is important enough to merit detailed consideration for two reasons. First, it is of interest in and of itself. Second, this is a useful testing ground for the theory and more structural empirical work: do these provide any insight into the movements of saving over time?

The aggregate series we shall concentrate on is the NIPA measure which gives what is widely regarded as the best measure of funds available for investment. In Table 4.1 we present two series for this measure from 1970 to 1990. These represent published values from 1988 and 1995. As can be seen, the two sets of figures tell rather different stories about the change in the saving rate in the 1980s. The earlier set of figures are those that gave rise to much of the debate recorded below but the later (revised) figures are, presumably, more reliable. For us, the important feature of the revised series is the abruptness of the

fall between 1984 and 1987.<sup>15</sup> The other important fact concerning the aggregate saving rate over time is that there has also been a long-term decline since the mid-1950s.

Bosworth, Burtless, and Sabelhaus (1991) use aggregate data to document that between 1976/80 and 1986/90 total private saving as a percentage of net national product fell from 9.2 percent to 6.3 percent.<sup>16</sup> Part of this fall was due to a fall in retained earnings by corporations, which went from 2.8 percent to 1.6 percent. Personal saving (total private saving minus retained earnings) fell from 6.4 percent to 4.7 percent. This change of  $-1.7$  percent also masks some important differences in composition:  $-1.3$  per-

<sup>15</sup> Detection of structural changes "by eye" is notoriously subjective and other viewers of the revised series may see more of a gradual decline from 1982 with 1984 as an outlier.

<sup>16</sup> The values from the revised figures reported in Table 4.1 are 7.1% and 4.6% respectively which indicates a similar fall in the rate.

cent was accounted for by changes in private pension reserves while state and local government pension saving actually increased by +0.5 percent. Nonpension saving by households ("other personal saving") fell from a rate of 3.2 percent to 2.2 percent which accounts for the other -1.0 percent. Thus the aggregate data suggest that the saving rate of households (net of pension and retained earnings) fell by about one third over this decade.

As discussed in Section 3, the treatment of durables, housing, pensions, inflation, and capital gains can distort the message of the aggregate statistics. It is thus legitimate to question whether accounting for these factors changes the pattern over time. Hendershott and Peek (1989) correct the ("old") official NIPA saving series by adding saving via net purchases of government pension assets (including social security, which is debatable) and consumer durables<sup>17</sup> and by subtracting the part of aftertax interest income attributable to inflation. Their finding is that the resulting alternative measures of the personal and private saving rate in the 1983–85 period are five percent (not percentage points) below their averages since 1950 and not, as reported in the official statistics, at all-time lows and 20 percent below their post-1950 averages. They also found that both personal and private saving have rebounded somewhat in 1983–85, again in contrast to the official series.

As mentioned before, the calculation of saving using the NIPA or FOF does

not take into account capital gains on the assets already in the portfolio of the households (see also David Bradford 1990). Skinner and Daniel Feenberg (1990) calculate an alternative measure of the saving rate that includes capital gains in housing and stocks (these gains are also added to national income). They find that this measure implied a saving rate of over 15 percent during 1983–88; this is approximately equal to the saving rate during the period 1974–79.

Given the many possible different definitions of saving, it is possible that some measures did decline and others did not. This is how we interpret the findings on the aggregate statistics that we have presented. If concern focuses on the flow of funds for investment purposes, then there probably was a substantial decline between the late 1970s and the late 1980s. On the other hand, there is much less evidence that wider measures of saving did experience such a sharp fall (if any at all).

The results discussed above are based on aggregate data. Before discussing the small amount of evidence on micro data we note once again that changes in aggregate and individual saving rates are not necessarily linked. At the end of Section 3.1 above we discussed why the levels of the saving rate might differ. The same is true of changes. Suppose, for example, that there is a redistribution of income from high savers to low savers. This will lower the aggregate saving rate even if individual saving rates remain constant for everyone.

The main study that documents the decline in saving using micro data is Bosworth, Burtless, and Sabelhaus (1991). As discussed in Section 3, the comparison between micro and macro data is not straightforward; many adjustments need to be made to make the different data comparable. Bosworth, Burtless, and Sabelhaus (1991) consider four major ad-

<sup>17</sup> Using aggregate data, David Wilcox (1991) documents that durable goods outlays have been the fastest growing category of real personal expenditure during the 1980s. They expanded at an average rate of 5% per year and in 1989 accounted for 16.1% of total personal consumption expenditure as against a share of 12.3% in 1980. Even though some of this variation may be due to cyclical variation it does appear that there has been an increase in the share of durables expenditures in the 1980s.

justments: the accumulation of reserves within private pension and welfare funds; home ownership and rental costs; business income; and third-party payments. They use data from two micro data sets: the CES and the SCF. On the CES, they define saving as income minus consumption and find that the national average saving rate fell from 15.1 percent in 1972/73 to 10.8 percent in 1982/85 (see Table 3.2). For the SCF they use panels in 1962/63 and 1983/85 and first difference wealth. The change here is from 14 percent in 1963 to 9.5 percent in 1985. Perhaps the most convincing aspect of this evidence is that two different surveys and two different measures are used yet the results are similar for both the levels and for the decline.

The micro figures referred to in the last paragraph take 1982/85 as the "later" period and indicate a decline from previous decades. The revised aggregate figures, however, show only a small decline for 1982/85 relative to the previous decade. Thus there is some ambiguity as to the exact date of the decline in the 1980s. There is general agreement, however, that there has been a much longer downward trend. We turn now to explanations of these changes in the saving rate.

#### 4.2 *Reasons for the Decline in the Saving Rate*

When discussing changes in the saving rate, it would be desirable to use directly the formal models that we discussed in Section 2 to organize our discussion. Unfortunately the CEQ model seems too narrow to be used in a discussion of this issue and more general models do not yield simple relationships that are easy to exploit. Thus we proceed by considering relatively informal analyses of the reasons for the decline in saving rates. Very broadly there seem to be eleven differ-

ent possible explanations so far explored in the literature: changes in the age structure of the population; changes in the saving propensities of different cohorts; changes in household structure; increased government insurance; changes in the distribution of income; the decline in aggregate growth; capital gains on housing; capital gains on stocks; the increased annuitization of wealth; cash payouts by firms to shareholders; and the development of financial markets. The variety of proposed explanations is per se an indication that there exists little consensus on what underlies the decline in saving rates. As well as these, there are also "behavioral" explanations that we shall also discuss.

The age structure of the population is the critical variable to consider in a Modigliani style life cycle model. If there is an increase in the proportion of the population that is elderly then we should expect the saving rate to decline because the elderly are supposed to be net dissavers. There seems to be a general consensus that this is not causing the decline (see, among others, Lawrence Summers and Carroll 1987; Alan Auerbach and Kotlikoff 1990; Bernheim 1991; and the discussion of Poterba to the paper of Bosworth, Burtless, and Sabelhaus 1991). Partly this is because saving rates do not seem to vary dramatically across age groups (see Table 3.2) and partly because the change in the age structure is too small to be able to explain the decline of saving in the 1980s.

An alternative to the "age" explanation is a "cohort" explanation: people coming to maturity in different times (the 1930s and the 1960s, say) may have different attitudes to risk, thrift, and borrowing (as well as many other things). Michael Boskin and Lawrence Lau (1988) find a substantial difference in the propensity to save by households born before and after 1939. This effect is substantial

enough, according to their estimate, that if the younger generation had the same saving propensities as the older cohort then the ratio of saving to GNP in the period 1963–80 would have been 10 percent higher. These findings are in contrast with the conclusions of Bosworth, Burtless, and Sabelhaus (1991). They interpret the finding that saving declined for almost every age group (again, see Table 3.2) to argue that there is no evidence that the decline is concentrated among households headed by members of the baby-boom generation. In fact, both the data sets they used indicate that the relative decline in saving has been smaller among younger households, while the decline is more pronounced for household aged 45 or older.

It may be that different investigators are drawing different conclusions from similar facts because they are using different (implicit) identifying assumptions. It is impossible to disentangle age, cohort, and time effects without some identifying assumption (because year of birth plus age equals the current year). We can illustrate this by considering Table 3.2 in which the age bands are ten years wide and the two data sets are ten years apart (so that the cohort aged 25–34 in 1972/73 is aged 35–44 in 1982/85). This allows us to read off cohort saving rates and see how they change over time. Looking at these “diagonals” for those aged under 54 in 1972/73 we see that cohort saving rates are fairly stable over time; the changes are only –1 percent, –1.6 percent, and –0.9 percent for the cohorts born in 1918–27, 1928–37, and 1938–47 respectively.<sup>18</sup>

To illustrate the importance of the identifying assumption in this context, suppose that we assume that there are no

age effects. Then Table 3.2 suggests a modest period effect (an average decline of about 1.2% with small intercohort differences) and strong cohort effects (with a bigger drop between the eldest cohort and the middle cohort than between the latter and the youngest cohort). Alternatively one can identify everything by assuming that there are no cohort effects. In this case, if there were no period effect (that is, no decline over time) then younger cohorts would behave just like older cohorts did the previous decade. That is, the youngest cohort would have had a saving rate of 12.1 percent in 1982/85 rather than the observed rate of 8.6 percent. This implies large period effects of –3.5 percent and –6.3 percent for the two youngest cohorts respectively. Thus different identifying assumptions give wildly different inferences from the same reduced form (in this case, six statistics in Table 3.2). Indeed, even the “fact” of the decline depends on the identifying assumption; in one case it is –1.2 percent and in the other, over –3.5 percent.

Not many studies have taken into account the effects of cohort when studying saving (but see the papers in the book edited by Poterba, 1994, for a cohort analysis of saving in the G7 countries). Attanasio (1993, 1994) does allow for cohort effects in an analysis that uses data from the CES. He finds a typical hump shaped age-saving profile, albeit with positive (median) saving for the elderly. According to Attanasio, during the 1980s the saving profile of people born between 1925 and 1939 shifted down (even though the decline in saving could also be potentially explained by a general shift in the age-saving profile for all cohorts). Attanasio also examines the sensitivity of his estimates to the choice of “consumption” and finds that part of the overall decline in saving (but not all) can be accounted for if durable expenditures

<sup>18</sup> We cannot use the cohort aged 55–64 in 1972/73 because the eldest group in 1982/85 includes a group who were older than 64 in 1972/73.

are considered as saving rather than consumption.

If the age structure of the U.S. population has not changed much over the past 20 years, the same cannot be said of other demographic factors, such as family composition. The 1980s witnessed an increase in one parent households, a decrease in average family size and in the number of children, and an increase in divorce and family dissolution. Many studies exclude "nonstandard" types of households but the saving behavior of these families can be of importance. Avery and Kennickell (1991) show that a large share of those who dissave (31.4%) is accounted for by households who experience a change in family status. James Smith (1994) also finds evidence that family dissolution has a strong influence on saving and wealth accumulation.

As discussed in Section 3, lone parent households have the lowest saving rate in the population and there has been a shift toward this type of family structure since the 1960s. Thus changes in the family composition of the population might be a candidate for an explanation for the decline in saving rates. On the other hand, the income of these types of families is simply too low to have much effect on the overall saving rate (see Bosworth, Burtless, and Sabelhaus 1991).

Because a simple CEQ model may not be able to account for the recent decline in saving, we next examine whether explanations connected to the precautionary saving motive are better suited to explain the empirical findings. As we will see later, it is not easy to test for the presence of a precautionary saving motive. Furthermore, it is sometimes difficult to draw a clear-cut distinction between precautionary saving and other motives. Thus, we provide hereafter only some informal discussion on the potential relevance of the precautionary saving motive.

Some authors argue that programs such as Medicare and Medicaid have decreased the need to provide for emergencies. The extent to which the population is insured against the need for large medical expenditure has increased dramatically since 1950 (see Summers and Carroll 1987). It is also possible that improved disability and life insurance coverage has reduced the extent of precautionary saving. The importance of these factors is also shown in simulations of models which include a precautionary saving motive (see Hubbard, Skinner, and Zeldes 1995). Skinner (1990) provides some evidence in favor of a decline in precautionary saving during the 1980s. Another aspect of the precautionary motive is the well documented increase in female labor participation. The potential income insurance provided inside the household when there is more than one earner could lead to a reduction in precautionary saving. Summers and Carroll (1987) consider this, but do not find evidence that two-earner families have contributed to the decline in saving.

Another important factor to consider is the distribution of income. In Section 3 we documented that it is high income households who are doing most of the saving. The shift in the income distribution toward increasing inequality might be expected to have increased the saving rate so that the decline net of this would have been greater. Bosworth, Burtless, and Sabelhaus (1991) examine the decline in saving across income classes and show that there is a uniform decline in saving across income quintiles. In fact, one of their main findings is that the saving rates of most population subgroups change in parallel over time. This suggests that the decline in saving must involve one or more factors that affect the great majority of households uniformly. They mention that one possible explanation for lower saving may involve

slower income growth. Traditional life cycle models cannot explain this positive correlation between aggregate income growth and individual saving rates (see Carroll and David Weil 1994). Carroll, Jody Overland, and Weil (1994) propose a model that includes habit formation (an "improvement motive" to use Keynes' terminology) to provide an explanation for the relation between saving and income growth and to potentially explain the decline in saving. This issue deserves more attention and more empirical work to be fully understood.

There are other explanations related to the distribution of income. In particular, the income of the elderly has increased substantially relative to that of the rest of the population. The primary cause of this improvement has been the dramatic increase in social security benefits (see Summers and Carroll 1987; and Hurd 1990). Insofar as this represents a transfer to a group with a low propensity to save it may be a partial explanation of any saving rate decline. The most dramatic imputation along these lines is due to Jagadeesh Gokhale, Kotlikoff, and Sabelhaus (1995) who estimate that if the government had not redistributed resources toward older people (from younger people and future generations) then the saving rate would have been three times as large as it actually is. As already discussed, this style of explanation does not require that behavior (saving rates) change at the household level to generate changes in the aggregate rate. Although plausible, this still leaves as an open question why the saving rates for younger households also fell.

Apart from income, wealth is another important economic variable to consider when examining the decline in saving. For example, one can ask whether the big capital gains on housing and stock prices have led to a decrease in saving. There are a few studies on this issue.

Bosworth, Burtless, and Sabelhaus (1991) documented, for example, that the decline in saving was higher for homeowners than for renters. Using the PSID, Skinner (1989, 1993) finds a small negative impact of increases in house values on saving. Hilary Hoynes and Daniel McFadden (1994) look at the same question as Skinner (1993) but come to different conclusions. Unfortunately, their sample selection and the variables under consideration are different so that it is difficult to identify the source of the different conclusions. They find a statistically significant but very small increase rather than a decrease in the saving rate consequent on an increase in real house prices. However, in other specifications they find much larger (positive) effects. Engelhardt (1995) finds results which are more in line with the Skinner (1993) estimates. However, he splits the gains in housing price into positive and negative capital gains and shows that it is only the negative gains that are related to saving. Therefore only people who experienced negative capital gains saved more, while the households who experienced positive capital gains did not change their saving. This work does not support the hypothesis that the decline in saving can be explained by the gains in the housing market.

As far as bonds and stocks are concerned, both Bosworth, Burtless, and Sabelhaus (1991) and Avery and Kennickell (1991) show that savings are higher among bonds and equity holders who represent about 30 percent of the population. Although the stock exchange market collapsed in 1987, the S&P Stock Index between 1983 and 1989 increased at a rate of 11.7 percent per year. There are only two studies which examine the effects of capital gains on stocks for saving. Bosworth, Burtless, and Sabelhaus (1991) found that the decline in the sav-



ing rate is actually smaller among bonds and stockholders than it is among households with no marketable financial assets. Similarly, Attanasio (1993) does not find any evidence that these capital gains have decreased saving.

Another potentially important change in the composition of wealth that has been explored in the literature is the remarkable increase in the annuitization of household wealth in the 1980s. To present just a few figures, Social Security benefits represent almost ten percent of U.S. personal income compared to only four percent in the 1960s. In 1962, nine percent of elderly Americans received income from private pensions; by 1988 this figure had risen to 29 percent. Also, while pension plans in the past represented only 5.2 percent of U.S. household net wealth, by 1990 they represented 16.5 percent (see Auerbach, Kotlikoff, and Weil 1992; and Auerbach et al. 1995). A larger share of annuitized resources may imply both a decreasing bequest motive (strictly, a reduced risk of accidental bequest) and a reduced precautionary motive (to allow for mortality risk) and hence higher consumption. According to Auerbach, Kotlikoff, and Weil (1992), while increased annuitization cannot explain all of the recent decline in the U.S. saving rate, it may represent an important piece of the puzzle. This explanation is again consistent with the evidence that saving has declined more for the older households.

There are also other "composition of wealth" effects that deserve mention. A number of authors have suggested that the cash payouts to share owners associated with corporate restructuring could be a factor explaining the decline in private saving (see, among others, Summers and Carroll 1987; George Hatsopoulos, Paul Krugman, and Poterba 1989; and Bernheim 1991). Summers and Carroll (1987) mention, for example, that in

1985 corporate share repurchases totaled \$27.3 billion and cash payments to shareholders in companies that were taken over totaled \$94.8 billion. Share repurchases and takeovers resulted in a flow of income equal to four percent of disposable income from the corporate to the household sector. If households consumed 50 percent of these payouts, the personal and private saving rates would have fallen between one and two percent. The problem with this explanation is that the pattern of declining saving is common to the young and people in the lower part of the income distribution who are unlikely to be receiving takeovers premiums or interest on junk bonds.

Other authors have noted that an important change in the 1980s was the development of financial markets and the potential lessening of financial constraints such as liquidity and downpayment constraints. The sharp increase in consumer credit relative to income in the 1980s suggests that households may need to do less saving before major purchases. Summers and Carroll (1987) show that the average down payment for first time homeowners has decreased substantially. Also households have taken up increasing amounts of debt, as is documented in Kennickell and Janice Shack-Marquez (1992) and Glenn Canner and Charles Lockett (1991). Some indirect evidence in support of this argument can be obtained by examining the evidence on mortgages (see Joyce Manchester and Poterba 1989). In a pair of papers, Tullio Jappelli and Marco Pagano (1989, 1994) have shown that consumption in Italy is affected by capital market imperfections. For example, they document that the excess sensitivity of consumption to current income across countries can be attributed to the characteristics of capital markets, in particular to the wedge between the borrowing and lending rates, downpayment ratios,

the size of the consumer credit market and other indicators of liquidity constraints, and an inability to borrow. If households cannot borrow the desired amount, then aggregate net saving will be higher than in the presence of perfect capital markets. Another useful application of these ideas can be found in Guiso, Jappelli, and Daniele Terlizzese (1991, 1994).

This explanation of the decline has testable predictions. If liquidity or downpayment constraints are important, then only certain age groups should be affected. Everything else being equal, the removal of constraints should decrease the saving rate of the young, while the saving of people close to retirement should not be affected by the removal of these types of market imperfections. As we have seen, however, the decline in the saving rate in the U.S. is greater for older households than for younger ones.

All of these explanations of the decline in saving rates can be captured in variants of the standard model. Some authors doubt that any of these explanations (individually or jointly) can provide an adequate account of the decline and conclude that it is necessary to resort to other (psychological) explanations (see Bernheim 1991; and Richard Thaler 1994). We shall discuss this approach at length in Section 7; for now we present some of the ideas that are relevant in the present context. For Bernheim (1991, 1994b), proponents of the psychological paradigm can better identify several factors that contributed to the decline in saving. One factor that economic psychology emphasizes is the impact of personal experience on expectations. For example, generations born after the Great Depression seem to be less worried about financial security and therefore less inclined to save. As economic hardship promotes conservatism, prosperity fosters extravagance. It is noteworthy

that the unprecedented decline in saving has coincided with the longest peacetime expansion on record. Bernheim (1991) suggests that these years of prosperity may have created a (false) sense of security. This explanation rests on the implicit assumption that it is changes in cohort behavior that have led to the decline. As seen above it is by no means certain that this is the case.

Proponents of the psychological paradigm also point to changes in the composition of income and wealth as explanations for the low rate of saving. But their rationale is in sharp contrast with the "economic" explanations previously mentioned. According to the psychological paradigm, some types of income are more "spendable" than others (see Hersh Shefrin and Thaler 1988). Individuals may have difficulty resisting the temptation to spend unless they have to take explicit steps in order to access income. As a result, they may save a very small fraction of items like interest income but a very large fraction of undistributed corporate profits. In the 1980s personal interest income rose dramatically as a percentage of private disposable income, while there was a 20 year decline in undistributed corporate profits, followed by a slight upturn in the late 1980s (see Bernheim 1991). Furthermore, investors swapped huge amounts of corporate equity for debt. As mentioned before, in the 1980s there was a wave of leverage buyout activity and a growing tendency for companies to repurchase shares. When stockholders tender their shares in a buyout or a repurchase agreement, they convert wealth to cash, at least temporarily. From a psychological perspective, the conversion shifts resources between "mental accounts." In particular, it transforms wealth into cash and investors may well be tempted to consume at least a portion of the proceeds. As before, this style of explanation has prob-

lems in explaining the widespread change in saving rates.

Changes in the aggregate saving rate over time constitute an important challenge for any model of saving. A "satisfactory" model of saving will need to explain not only cross-sectional behavior but also changes over time. In this section we have reviewed a number of papers that were motivated by the decline in the U.S. saving rate. Although we have learnt a good deal about saving behavior from these studies it remains to make a judgment as to whether they have helped us to understand the decline itself.

In evaluating the different explanations, two aspects of the saving decline deserve emphasis. First, there is the abruptness of the change in the aggregate series in the mid-1980s. Second, there is the fact that however we stratify the data (by age, income, shareholding, etc.) there seems to be evidence of a decline across diverse groups; albeit with different changes for different groups. These two facts seem to rule out most of the explanations given above. Some operate over too long a time period and do not show evidence of any sharp change in the mid-1980s. Others would imply changes in only some subgroups. Thus it is our belief that we are still some way from having a convincing explanation of the saving decline. This is reflected in the fragmented discussion given above.

To develop an adequate explanation we need to identify more precisely the determinants of saving and consumption at the household level. This requires the specification and testing of specific models. It is to this that we now turn.

## 5. *Empirical Results on Short-Run Intertemporal Allocation*

### 5.1 *Econometric Issues*

As discussed in Section 2, most empirical work on intertemporal allocation

using micro data has concentrated on the Euler equation for allocation between different periods. Thus we devote a good deal of space to this empirical work. In this subsection we discuss the econometric issues that arise in estimating Euler equations and in the following subsection we present some of the results. In Subsection 5.3 we present a discussion of the empirical evidence that focuses specifically on the precautionary motive. Although important, the implications for the Euler equation do not exhaust the predictions of the standard model; in Section 5.4 we consider tests of some other implications of the model.

There are a number of issues for modeling Euler equations. The issues we discuss here are: whether to model consumption or saving; the choice of functional form; the use of approximations to the Euler equation; dealing with the unobservability of consumption shock variances; the choice of goods to model; how to handle differences between the information sets of agents and econometricians; the stochastic specification and measurement error and the length of the sample period.

The first issue is whether to model consumption or saving. Most studies on the micro data choose to model consumption. This is either because the theory underlying the analysis is a theory of consumption or because a saving measure is not available or is deemed too noisy. As discussed in the last section, few panel data sets have wealth measures or good information on consumption and income. Moreover, even if wealth data is available, we need to first difference to derive saving so it is likely to be noisier than consumption. For evidence on this issue, see Attanasio (1993), Marjorie Flavin (1991), and Alessie and Lusardi (1993) who all have recourse to robust estimation.

The next issue involves functional form. This has generally been treated in an ad hoc way. The usual choice is the iso-elastic (CRRA) form. It is not completely clear why this is, because the CRRA form has some shortcomings. The principal of these is that the intertemporal substitution elasticity is constrained, a priori, to be independent of wealth (that is, it is the same for rich and poor) and there is only one parameter to control for intertemporal allocation (or risk aversion) and prudence. Among the criteria that should guide the choice of functional form are: congruence with theory (we should be able to impose theoretical restrictions in a simple way); flexibility (for example, important elasticities should not be constrained to be constant); and econometric tractability (for example, linearity in parameters is desirable). The usual approach to choosing a functional form is to choose a (one good) utility function and then to differentiate it to give the marginal utility of money. In Attanasio and Browning (1995) an alternative approach is adopted: a tractable and flexible Euler equation is chosen directly. If desired, this can be integrated back to the utility function. This procedure allows these authors to find a simple functional form that nests the CRRA form and avoids the two problems mentioned above. Attanasio and Browning (1995) find that the CRRA is decisively rejected against the more general alternative.

The next issue involves the choice of whether to estimate exact or approximate Euler equations. The theory states that the marginal utility of expenditure is a martingale; thus an exact approach would derive the marginal utility of expenditure and then first difference. If we choose the CRRA form, from (2.1) and (2.2) we have (ignoring demographics for the moment):

$$\beta(1+r_t)(C_{t+1})^{-\gamma} - (C_t)^{-\gamma} = e_{t+1}$$

where  $E_t(e_{t+1}) = 0$ . (5.1)

There are two major problems with estimating this. First, it is nonlinear in parameters. This is not too much of a problem; much more serious is that  $C$  is likely to be measured with error and we have no satisfactory way of dealing with measurement error in nonlinear equations. These considerations have led investigators to use the approximation given in (2.4):

$$\Delta \ln C_{t+1} = \beta + \phi r_t + 0.5\phi\sigma_{t+1}^2 + u_{t+1}$$

where  $E_t(u_{t+1}) = 0$ . (5.2)

This is linear in parameters and measurement error in consumption can be readily dealt with. The problem with this approximation is that it has introduced a new (unobservable) variable,  $\sigma_{t+1}^2$ , into the analysis.

The inclusion of the variance term in (5.2) seems to give considerable problems (see Subsection 5.3 below) so it is tempting to use the exact form and avoid these problems. If we can overcome the nonlinear measurement error problem, the exact approach with a CRRA form gives the same information about behavior as approximations even if the latter includes some valid proxy for the consumption shock variance. This is because the parameter  $\gamma$  governs both intertemporal substitution and prudence; from an estimate of  $\gamma$  we can predict the reaction to an increase in  $\sigma_{t+1}^2$ . Of course, the addition of a valid proxy for this variance may give more precise estimates if the restriction on the coefficients in (5.2) is not rejected but formally estimates from the exact form give all the information concerning saving behavior. Our own feeling is that this comes dangerously close to identifying precautionary saving off of functional form (specifically the

imposition of the CRRA form) and is not robust. This is compounded by the fact that the  $\gamma$  parameter is not usually precisely estimated.

The next issue we discuss is the choice of good to model. This is often forced on us by data. For example, the PSID has two food expenditures ("food at home" and "food outside the home"; but see Skinner, 1987, for a more ambitious attempt to use other information in the PSID). The U.S. CES and the U.K. FES have much wider and more reliable measures of consumption but very little panel aspect (in fact, none for the FES). A minimum preferred set of measures would be for the purchases of nondurables and stocks of durables. While the latter may be possible for cars, it is not for other durables.<sup>19</sup> In fact, though, investigators usually take what is given and assume additivity of any goods to hand from all other goods.

Most widely used additive separability assumptions are dubious at best. It is difficult to believe that preferences over nondurables are separable from the stock of durables. For example, the latter depends on car ownership and gas and bus expenditures are included in nondurables. It seems a priori incredible that preferences as between gas and bus expenditures should be independent of car ownership. Similar remarks apply to housing and, say, heating expenditures. As far as we are aware there is no systematic discussion anywhere of the likely biases that ignoring nonseparabilities may induce in estimates of the Euler equation.

For some purposes it may be sufficient to observe only a single good, even if this is not separable from other goods. For example, to test the over-identifying restrictions we need include only the

changes in discounted prices of all goods in the (Frisch or  $\lambda$ -constant) demand function for the good we observe. Although this justification for ignoring other goods may be valid for nondurables and some durables (if we include the user cost of the latter), it will not hold for other important "goods" such as housing or labor supply. For these there is no price that we can plausibly include on the right hand side of the Euler equation that will pick up the effects of these goods.<sup>20</sup>

Because the PSID has only food expenditures it is worth spending some time examining this specific case. There are two problems with the food measure in the PSID. The first is how noisy it is. Thus David Runkle (1991) estimates that 76 percent of the between year variation in food expenditures is noise.<sup>21</sup> The second problem is that it is ambiguous as to what period the food measures in the PSID cover. This presents problems for the timing of the arrival of new information. The question is formulated as follows: "How much do you spend on food in an average week?" Responses are collected in the Spring and they may pertain to the first quarter of the interview year or to the past year. This is not a trivial issue given the importance of timing the instruments correctly and of knowing precisely the information set.

A far better measure of consumption would be expenditure on nondurables in a given period. Unfortunately there is very little panel data that has such information. For developed countries the only panel data sets we are aware of are for Japan and the U.S. (both four quar-

<sup>20</sup> The use of the discounted marginal wage (even if available for all adult members of the household) has the usual problem that it relies too strongly on the life-cycle model of labor supply with spot markets to be widely acceptable.

<sup>21</sup> In an unpublished paper, Matthew Shapiro (1982) has the even more alarming estimate of 95%.

<sup>19</sup> Even in surveys where the ownership of particular durable goods is recorded, the actual value of these is not.

ters; see Hayashi, 1985, for results on the Japanese data set) and Norway and Spain (both eight quarters; see Knut Mork and V. Kerry Smith 1989; and Browning and Dolores Collado 1994, respectively). Although these panels are likely to be informative, their limited duration reduces their usefulness. This is particularly the case for the four quarter surveys because the longer surveys suggest that there are important seasonal effects in consumption and income processes.

One way to circumvent the lack of long panels with reliable and full consumption information is to use long time series of expenditure surveys to construct quasi-panel (or "cohort mean" or "synthetic panel") data (see Browning, Deaton, and Margaret Irish 1985). This method follows the same cohort over time by taking means of variables for, say, 30 year olds in one year and 31 year olds in the next year and then treating these means as panel data observations on the same "individual." These quasi-panels have some advantages over true panels. For example, we can construct very long panels (over 20 years for the U.K.) with no attrition. There is also less measurement error than in the PSID and averaging takes some of that away. On the other hand, small cell sizes reintroduce measurement error in the form of sampling error (consumption and income are correlated in cross-section even if the CEQ model holds). It is also the case that some dynamic processes cannot be modeled with quasi-panels (see Robert Moffitt 1993).

If we do have data on many goods (as in quasi-panels, for example) and wish to model consumption rather than individual (constant- $\lambda$  or Frisch) demands then we need to be clear how consumption is defined. This is relatively straightforward: some measure of total expenditure on many goods, denoted  $x$ , is taken and

then it is divided by some price index, denoted  $P(\mathbf{p})$  where  $\mathbf{p}$  is the price vector for the many goods available in the period. The result is "consumption." The conditions under which this procedure is valid (which are much weaker than within period homotheticity) are given in William Gorman (1959).<sup>22</sup>

The next issue we consider is that the information set of econometrician and agent obviously differ. If we follow the usual practice and assume that agents know everything available to the econometrician then any lagged variable observed by the econometrician is a valid instrument. The problem that arises is that while the agent may know everything the econometrician does (at least, about the agent's variables) the econometrician may not know very much that is of relevance for the agent. This will lead to a lack of power in tests of the over-identifying restrictions that are the main vehicle for testing the predictions of the model. The other problem that may arise is the exact opposite of this: the investigator may use information that was not a part of the agent's information set (see Pischke 1995). In this case the instruments may not be orthogonal to individual consumption changes.

We turn now to the stochastic specification. A major part of this is the accounting for heterogeneity. To see how we handle this, consider again equation (2.4). Apart from the need to allow for changes in demographics we can also allow that the discount factor and the intertemporal substitution elasticity vary across agents. Finally, we might want to include a person specific fixed effect in the discount factor. This has the virtue of absorbing any fixed part of the (unobservable) consumption variance term.

<sup>22</sup> See Richard Blundell, Browning, and Costas Meghir (1994) for an empirical demonstration that the choice of price index in this context does not much matter.

The drawback of including fixed effects is that we lose efficiency if the fixed effects are not required and we have to be much more careful about exogeneity. In particular, we cannot use a "within" estimator because the instruments are not strongly exogenous (see Michael Keane and Runkle 1992). Finally, we can allow for white noise taste shocks, while recognizing that this induces an  $MA(1)$  structure into the error term which invalidates the use of once lagged instruments.

As already discussed, most of the variables used in an Euler equation are likely to be subject to considerable measurement error. Multiplicative measurement error in the consumption measure used in (5.2) invalidates once lagged consumption growth as an instrument (but not necessarily other once lagged variables which are orthogonal to measurement error on consumption). The problem with dropping this instrument is the usual one: we lose power. On the other hand, the results of Joseph Altonji and Aloysius Siow (1987), Julie Nelson (1994), and Lusardi (1996) suggest strongly that not taking serious account of measurement error can lead to bias. Generally, because the use of twice lagged instruments allows us to take care of measurement error, white noise taste shocks, and time aggregation all at once, dropping once lagged instruments seems like a very sensible precaution if identification can be achieved without them.

Finally we come to the issue of the sample period. As discussed in Gary Chamberlain (1984) the orthogonality conditions apply across time for each individual and not across agents. Thus the usual asymptotic results only hold as the number of time periods in the panel become large. As the discussion in Randall Mariger and Kathryn Shaw (1993) and Deaton (1992) makes clear, if the panel used is short then the usual orthogonal-

ity conditions will not hold if there are common (macro) shocks<sup>23</sup> and these impact on different households in different ways. Although there is no strict answer to how long a panel needs to be it seems that a minimum of, say, two business cycles (15 years) is desirable. If this is the case, then this invalidates most Euler equation studies except for those that use (long) quasi-panels.

## 5.2 Euler Equation Estimates and Tests

There have been a great number of Euler equation consumption studies over the past few years; in Table 5.1 we list 25 such studies that have used micro data from various developed countries. There is a wide variety in the specifications used in these papers. As evidence of this, in Columns 2 to 6 we present the data set; the sample period; the utility function used; a list of controls for taste shifters; and the consumption measure used. There are also other important differences in specification (for example, the inclusion of a fixed effect) which it is difficult to tabulate but which must be kept in mind.

Although most investigators have some discussion of their substantive findings it is the case that almost everyone concentrates on the implications of their results for the validity of the standard additive model. The generic test is the test of the over-identifying restrictions from the orthogonality condition. One problem with it is that it may have low power. Thus most investigators seek to enhance the power of their tests by concentrating on specific alternatives to the standard additive model.

Of these more focused tests, the one

<sup>23</sup> Many studies account for the effect of common macro shocks by inserting time dummies in the Euler equations. Sumru Altug and Miller (1990) provide a rigorous interpretation for this by appealing to the restrictions implied by the complete market assumption.

TABLE 5.1  
CONSUMPTION EULER EQUATIONS USING MICRO DATA

Authors	Data Set	Sample Period	Preferences	Controls for Taste Shifters
Hall & Frederic Mishkin (1982)	PSID	1968–75	Quadratic	Age, # of children and adults
Bernanke (1984)	SCF	1967–70	Quadratic	Age, # of adults, occupation
Browning, Deaton, & Irish (1985)	FES	1970–76	General	# children, occupation
Hayashi (1985)	SFC (Japan)	1981:2–1982:1	CARA	None
Altonji & Siow (1987)	PSID	1968–81	CRRA	Age, education, children, area, marital status
Mork & V. K. Smith (1989)	CES (Norway)	1975–77	Quadratic	Age, children, family size
Zeldes (1989a)	PSID	1968–82	CRRA	Age, family size
Altug & Miller (1990)	PSID	1968–83	CRRA	Age, size, and sex composition of household
Maureen Lage (1991)	PSID/CES	1974–84	Quadratic	Age, # of adults & children
Emily Lawrence (1991)	PSID	1974–82	CRRA	Age, family size, race, education
Runkle (1991)	PSID	1973–82	CRRA	Age
Keane & Runkle (1992)	PSID	1975–82	CRRA	Age
Attanasio & Weber (1993)	FES	1970–86	CRRA	# of adults, education, labor supply
Engen (1993)	PSID-CES	1977–87	CRRA	Family size, sex, race
Mariger & Shaw (1993)	PSID	1968–81	Quadratic	Age, # adults, # children
Meghir & Weber (1993)	CES	1980–87	Direct translog	Age, # of adults, # children, race, education, tenure, area, labor supply
Attanasio & Browning (1995)	FES	1970–86	Generalized CRRA	Age, # children, family size, labor supply
Attanasio & Weber (1995)	CES	1980–90	CRRA	Family size, # children, marital status, labor force variables
Blundell, Browning, & Meghir (1994)	FES	1970–86	General	# children, housing tenure, family size, labor supply
Janice Eberly (1994)	SCF	1983–86	CRRA	Family size, # children, marital status, labor force participation
Engelhardt (1996)	PSID	1975–87	CRRA	Age, family size, marital status, education, race
Garcia, Lusardi, & Ng (1994)	CES-PSID	1980–87	CRRA	Age, family size
Jappelli, Pischke, & Nicholas Souleles (1995)	PSID-SCF	1971–86	CRRA	Age, # of children, # of adults <sup>†</sup> , employment status
Shea (1995)	PSID	1981–87	CRRA	Family composition
Lusardi (1996)	CES-PSID	1980–87	CRRA	Age, family size



Table 5.1 (cont.)

Authors	Consumption Measures	Excess Sensitivity (se)	Other Implications
Hall & Frederic Mishkin (1982)	Food	0.200 (0.065)	—
Bernanke (1984)	Automobile	-0.0136 (0.019)	—
Browning, Deaton, & Irish (1985)	Nondurables	—	Reject symmetry with male labor supply
Hayashi (1985)	Seven consumption goods	0.158 (0.020)	Durability of services is substantial
Altonji & Siow (1987)	Food	0.091 (0.091)	Weak evidence of asymmetries
Mork & V. K. Smith (1989)	Five consumption goods	0.378 (0.151)	Food not representative of consumption
Zeldes (1989a)	Food	0.071* (0.016)	—
Altug & Miller (1990)	Food		Importance of macro shocks & nonseparability
Maureen Lage (1991)	Total consumption	0.212 (0.023)	Measure of consumption matters
Emily Lawrence (1991)	Food	Consumption is sensitive to income	Varying time preferences across households
Runkle (1991)	Food	0.018* (0.015)	Measurement error in food
Keane & Runkle (1992)	Food	-0.011* (0.008)	—
Attanasio & Weber (1993)	Nondurables	0.119 (0.145)	Aggregation problems
Engen (1993)	Nondurables	-0.004* (0.005)	Mortality risk is important
Mariger & Shaw (1993)	Food	No evidence of excess sensitivity	Relevance of macro shocks
Meghir & Weber (1993)	Food; transport; services	No evidence of excess sensitivity	Test of intertemporal non-separabilities
Attanasio & Browning (1995)	Nondurables	0.086 (0.073)	—
Attanasio & Weber (1995)	Food; nondurables	0.100 (0.103)	Nonseparability between food & nondurables
Blundell, Browning, & Meghir (1994)	Six consumption goods	0.545 (0.368)	Importance of demographics & labor supply
Janice Eberly (1994)	Automobiles	-0.30* (0.15)	Evidence of transaction costs
Engelhardt (1996)	Food	0.043 (0.035)	Test for down payment constraint
Garcia, Lusardi, & Ng (1994)	Food; Nondurables	0.561 (0.207) 0.284 (0.148)	Allowance for asymmetry in expected income changes
Jappelli, Pischke, & Nicholas Souleles (1995)	Food	0.012* (0.027)	—
Shea (1995)	Food	0.063 (0.785) 2.242 (0.951)	Allowance for asymmetry in expected income changes
Lusardi (1996)	Food; Nondurables	0.368 (0.135)	Measurement error in CES income

Data sets-OSUD: Panel Study of Income Dynamics (USA), CES: Consumer Expenditure Survey (USA), SCF: Survey of Consumer Finance (USA), FES: Family Expenditure Survey (U.K.), SFC: Survey of Family Consumption (Japan). \* For the parameter of "excess sensitivity" for lagged income (so that a negative sign signifies excess sensitivity); for all other studies the parameter given is for (instrumented) income growth or change (So that a positive sign signifies excess sensitivity)

The two estimates for Garcia, Lusardi, and Ng (1994) refer to constrained and unconstrained groups respectively. The two estimates for Shea (1995) correspond to positive and negative expected income growth respectively.

that has received the widest attention is the possible (partial) correlation between realized consumption changes and either lagged earnings or predicted changes in earnings. In Column 7 of Table 5.1 we present the results of one or other of these two (excess sensitivity)<sup>24</sup> tests. Finally, in Column 8 we present some of the other implications of the results reported.

As discussed in Section 2 and in the previous subsection there are a number of specific alternatives that might lead to a failure of the orthogonality conditions. Some of these are consistent with the standard additive model: nonseparability of the good modeled from labor supply or housing; using the approximate Euler equation without taking account of the error variance term—see equation (5.2) above; the use of the wrong functional form; the use of instruments that were not in the agents' information set; the exclusion of predictable variables that do affect consumption (for example, changes in demographics or the real rate); or the use of inappropriately short panels. Alternatively it may be that the orthogonality conditions fail because some assumption of the standard model is wrong. For example, there may be intertemporal nonadditivities in preferences (due to habits or durability); liquidity constraints; the existence of some groups whose members simply spend a fixed proportion of current income ("rule of thumb" behavior) or serially correlated taste changes.

There are two issues here. First, do the orthogonality conditions fail? Second, if they do fail, what are the implications of this failure? It will be clear from the list given in the previous paragraph that even if we do observe failures of the orthogonality conditions, the standard

additive model has a number of "life belts" that may save it from drowning. This is not to suggest that the standard additive model is correct but rather that testing for its validity is a good deal more difficult than is often supposed.

To develop a specific alternative, we start with what is far and away the most widely questioned assumption used in the standard additive model: the absence of liquidity constraints. Two closely related approaches have been used to derive observable implications of the presence of liquidity constraints. The first derivation can be used if we have information on asset levels. To illustrate this we consider the influential study of Zeldes (1989a) which provides what is probably the most widely cited Euler equation evidence against the model that assumes perfect capital markets. Zeldes actually provides three tests of which the first is considered the most telling. In this test he splits his sample into those with high and low assets at the beginning of the period<sup>25</sup> and then includes lagged income levels in each of the Euler equations for each group. He finds that the lagged income term is only significant for the low asset group.<sup>26</sup> This exemplifies two important features of the analysis. First, the splitting into groups on the

<sup>25</sup> Splitting by asset levels is not the only way to split the sample. For example, Jappelli (1990) uses data from the Survey of Consumer Finances on credit refusal or being a discouraged borrower. He finds that not only financial assets or wealth, but also age, race, family size, marital status, and income are important determinants of being refused credit or being a discouraged borrower. John Caskey and Andrew Peterson (1994) also indicate that demographics may be important indicators of being constrained.

<sup>26</sup> It should be noted that the validity of this empirical finding is not universally accepted. For example, Zeldes allows for a fixed effect by including person specific dummies. This is not valid if the instruments are predetermined but not strictly exogenous, see Keane and Runkle (1992). They show that using an alternative (consistent) estimator leads to quite different qualitative results concerning excess sensitivity.

<sup>24</sup> The term was first used by Flavin (1981) in the context of a CEQ model; we use it here to refer to a more general failure of the model.

basis of beginning of period assets raises the power of the test; if we pooled both groups then the coefficient on lagged income would be "less significant." The test also facilitates identification: Zeldes (1989a, p. 322) remarks that "it seems unlikely that [a failure of assumptions not connected with liquidity constraints] would lead to a rejection for low-asset consumers but not for high-asset consumers."

The standard additive model is, however, not so easily disposed of. As Carroll (1992, 1993) notes, such an outcome might well be expected even if there are no liquidity constraints. If there is a precautionary motive then we should include a variance term in the Euler equation; see equation (5.2). This variance term is small for those with high assets. Among those with low assets, however, agents who have low income (relative to their "permanent" income) will have a higher variance and hence will have higher consumption growth (on average). This leads to a negative correlation between lagged income and consumption growth for this group which is exactly what Zeldes observes. Similar remarks can be made for the other two tests of Zeldes. Thus Carroll accepts the rejection of the over-identifying restrictions but infers from this that there is a significant precautionary motive rather than that some agents are liquidity constrained.

If asset levels are not observed then we may have recourse to the test which includes instrumented earnings growth in the Euler equation. Because this is a function of lagged variables (and any current variables that are perfectly anticipated) it should be uncorrelated with consumption growth. As can be seen from the number of unstarred coefficients in Column 7 of Table 5.1 this test has been used very widely.

A study of Table 5.1 suggests that

there is no consensus at all on whether there is excess sensitivity. Just about the same number of studies find evidence of it as do not. It is frustrating in the extreme that we have very little idea of what gives rise to the different findings. Mariger and Shaw (1993) give some indications for papers estimating CEQ models on the PSID but we still await a study which traces all of the sources of differences in conclusions to sample period; sample selection; functional form; variable definition; demographic controls; econometric technique; stochastic specification; instrument definition; etc.

Studies that use quasi-panel data generally do not find evidence of excess sensitivity. Attanasio and Browning (1995) present evidence that this is more because these studies treat demographics and labor supply satisfactorily than because of differences in the data set. Using Euler equations that do not control adequately for demographics they find evidence of excess sensitivity. However, including controls for demographics and age or labor supply this evidence disappears. Because income, labor supply, and demographics are all correlated over the life cycle it is no surprise that allowing for the latter two reduces the importance of the former. Thus the results of Attanasio and Browning (1995) are better thought of as showing how difficult it is to find convincing tests for excess sensitivity rather than as evidence for or against any particular variant of the standard model.

One important feature of Column 7 of Table 5.1 is that almost all studies find that the expected income growth (or lagged income) variable has the "predicted" sign (that is, expected income growth has a positive coefficient and lagged income a negative one).<sup>27</sup> Even

<sup>27</sup> And the two that find the "wrong" sign—Ben Bernanke (1984) and Runkle (1991)—have low *t*-values.

though many of these studies use the same data set, this seems somewhat unlikely if there is no excess sensitivity.<sup>28</sup> This suggests that the insignificant findings are the result of low power rather than a nonrejection of the orthogonality conditions. There is also other evidence that many tests of excess sensitivity may have low power. Very few studies present measures of fit for the auxiliary equation used to predict income growth but those that do (Altonji and Siow 1987; Lusardi 1996; and Attanasio and Guglielmo Weber 1995) report very low  $R^2$ 's. In the three cases where authors take especial care to increase the predictive power of the income growth equation (Lusardi 1996; John Shea 1995; and René Garcia, Lusardi, and Serena Ng 1994) the investigators do find evidence of excess sensitivity.<sup>29</sup>

One other tentative conclusion for modeling that emerges from the studies cited in Table 5.1 is the importance of allowing for measurement error. The papers that account for measurement error (for example, Altonji and Siow 1987; and Runkle 1991) do not find evidence of excess sensitivity. However, this may simply be because allowing for measurement error further reduces the power of the test for excess sensitivity.

Although they are not conclusive, sup-

pose that we do take the results presented in Table 5.1 to indicate that there is excess sensitivity. As we have discussed at length, the inference to be drawn from this is not obvious. One possible source of identification is to note that there is an asymmetry in the response of consumption growth to expected income growth if there are liquidity constraints but not if consumers use a "rule of thumb." If income growth is expected to be negative then liquidity constrained agents can smooth by saving. It is only when income growth is expected to be positive that consumers may find themselves constrained and hence having to set consumption changes equal to income changes. Thus we could allow for nonlinear effects of expected income growth (for example, by including positive and negative income growth as separate regressors; see Shea 1995; and Garcia, Lusardi, and Ng 1994) and test for linearity. Note, however, that Shea allows for asymmetric effects but finds the exact opposite of the prediction from a model with liquidity constraints.

As an example of identification that uses a somewhat more structural approach, Meghir and Weber (1993) provide a test that allows us to discriminate between liquidity constraints and intertemporal preference dependencies. Because both these departures from the basic model give that lagged consumption behavior influences current consumption it is not clear how we can decide between them on the basis of a test that uses the latter. Rather than looking at total consumption, Meghir and Weber exploit the differential impact of these two departures on the structure of demand. Broadly, liquidity constraints may affect the allocation of total expenditure to a period but they should not affect the dispersal of this total over different goods. On the other hand, habits will lead to different effects of past demands

<sup>28</sup> Note, however, that this could be due to publication censoring: investigators who find the "wrong" sign may continue with specification searches until they have the "right" sign.

<sup>29</sup> Another response to the low power is to use data that give large and observable income shocks. Thus Browning and Crossley (1995) use a large sample of unemployed workers to investigate the sensitivity of expenditures to Unemployment Insurance (UI) benefits. The reasoning here is that the unemployed are likely to have current income that is below "permanent" income and are also unlikely to be able to borrow from conventional sources. If this group is not liquidity constrained then it seems unlikely that anyone will be. These authors find that only those who had no liquid assets at their job loss are sensitive to the level of UI benefits.

on the current structure of demand, even when we condition on total expenditure.<sup>30</sup> In the event, they do not find significant evidence of either habits or of liquidity constraints.

In the end, the results on the validity of the standard additive model from consumption Euler equations are deeply ambiguous. Given Table 5.1, it is not difficult to find evidence to cite for or against the standard additive model (or even the additive CEQ model). Some would argue that there is no strong evidence of nonorthogonality. Others would allow that there is, but this is consistent with the standard additive model. Even for those who do not take these views, there may still be disagreement about which of the standard additive assumptions are failing. Thus these results are such that no one coming to this literature with even mild priors concerning the importance of, say, liquidity constraints is going to go away with different opinions. As evidence of this, we disagree: Browning feels that, based on the results in Table 5.1, there is no strong evidence against the standard additive model while Lusardi believes that there is. Although a full "sensitivity" study on the PSID would be extremely useful we feel that it is unlikely that any really convincing evidence regarding the validity of the standard additive model is going to be found using Euler equations on data of the sort used in Table 5.1.

### 5.3 Empirical Evidence on the Precautionary Saving Motive

Given the central place that the precautionary motive has assumed in the theoretical literature it is not surprising that there have been several recent attempts to quantify the importance of this motive. Some of this has taken the form

<sup>30</sup>So long as we rule out models in which past behavior only affects the discount factor, as in Hirofumi Uzawa (1968).

of matching results of simulations to broad facts; we shall discuss this in the next section which deals with life-cycle saving. There has also been a good deal of work on the short-run implications of the precautionary motive and it is to this that we now turn.

All of the recent empirical studies have followed the route of including some measure of risk either in a consumption, saving, or wealth equation or in an Euler equation and then testing for its significance. In Table 5.2 we list a number of studies that follow this approach. As can be seen, a wide variety of left hand side variables and measures of risk have been used.

The central problem that faces anyone who wishes to determine the role of precautionary saving in this way is to identify some observable and exogenous source of risk that varies significantly across the population. All three adjectives (observable, exogenous, and variable) are operative here. As regards observability: we obviously need to observe either some measure of risk directly or some proxy for it if we are to include it as a "right hand side" variable. Some investigators use measures of income variance that are derived from observed income processes (see Carroll 1994; Carroll and Andrew Samwick 1995a, 1995b; and Mark Kazarosian 1994). These are sensitive to assumptions about measurement error and how much the agent knows that the econometrician does not. Another approach is to proxy risk with the variance of consumption in an Euler equation (see Michael Kuehlwein 1991; and Karen Dynan 1993). This is problematic if there is cross-agent variation, measurement error, or some durability in the consumption measure used in estimation. Direct measures of subjective measures are more attractive in this respect (see Guiso, Jappelli, and Terlizzese 1992, 1996; and Lusardi 1993) but they

TABLE 5.2  
EMPIRICAL EVIDENCE FOR PRECAUTIONARY SAVING

Authors	Data Set	Left Hand Side Variable	Measure of Risk	Main Finding
er (1988)	CES	Saving rate	Occupation dummies	No evidence of precautionary motive
lwein (1991)	PSID	Food consumption growth	Variance of forecast error of Euler equation	No evidence of precautionary motive
o, Jappelli, & zzese (1992)	SHIW (Italy)	Wealth and consumption relative to permanent income	Subjective earnings variance	Precautionary motive explains 2% of wealth accumulation
i (1993)	CES	Consumption growth	Variance of consumption growth	No evidence of precautionary motive
rdi (1993)	SHIW (Italy)	Wealth relative to permanent income	Subjective earnings variance	Precautionary motive explains 13% of wealth accumulation
oll (1994)	CES & PSID	Consumption	Income variance, equivalent precautionary premium	All measures of risk negatively related to consumption
o Jappelli, & zzese (1996)	SHIW (Italy)	Share of risky assets in the portfolio	Subjective earnings variance and health risk	Risk decreases the demand for risky assets
rosian (1994)	NLS	Wealth relative to permanent income	Income variance	Doubling variance increases wealth/permanent income ratio by 29%
oll & Samwick (1995a)	PSID	Log wealth	Income variance	Strong positive relationship between income variance and wealth
oll & Samwick (1995b)	PSID	Log wealth	Income variance, equivalent precautionary premium	Precautionary motive explains about 40% of wealth accumulation
en & Jonathan oer (1995)	SIPP	Wealth relative to permanent income	Unemployment insurance replacement rate	Raising the replacement ratio by 10% lowers wealth by 1.4–5.6%
rael Palumbo (1995)	Maine Workers' Survey	Saving (binary variable)	Earnings variance, union membership	Income risk increases saving
tha Starr-McCluer (1996)	SCF	Log wealth	Health insurance coverage	Mixed evidence of precautionary saving

are problematic because they depend on the answers to questions that respondents may not understand well or may not have any incentive to answer accurately.

Sizable variability in the measure of risk is also important because most of the left hand side variables that have been suggested as regressors (for example, saving rates or wealth to permanent

income measures) are likely to be quite noisy.

The exogeneity issue is, however, the most problematic. The issues can be illustrated by referring back to one of the (many) tests in Friedman (1957). Suppose we calculate saving rates for agents who are in different occupations (see, for example, Skinner 1988). If we can order occupations by the earnings risk attached to them, then we can check whether saving rates are significantly higher for those in riskier jobs. The problem with this is that the agent's choice of occupation may be correlated with attitudes to risk. Suppose, for instance, that risk aversion and prudence are positively correlated across the population. Risk averse agents will choose less risky jobs but they will also be more prudent and, *ceteris paribus*, save more. Thus even if there is a strong precautionary motive for all agents we may not observe a positive cross-section correlation between earnings risk and saving rates. Conversely, a negative correlation between risk aversion and prudence will lead us to underestimate the precautionary motive.

The problem here is compounded by the fact that earnings risk may also be correlated with other important aspects of earnings. For example, risk and the time path of earnings may be correlated (for example, flat paths may be less risky) so that some of the observed variation in saving rates may be associated with variation due to the life-cycle motive rather than to the precautionary motive. Equally, the rate of return may be correlated with risk. One example would be for self-employed people. They may face riskier income streams but with much higher rates of return on investments in their own business. Thus risk is negatively correlated with (expected) return. In this case the precautionary motive is confounded with the intertemporal substitution motive.

To circumvent the endogeneity problem, Friedman (1957) suggests another source of variation in earnings risk that we can take as exogenous: race. If blacks face higher earnings risk than whites then this should lead to them having higher saving rates. The problem here is that although the source of variation may be taken to be exogenous, preferences may also be correlated with race. For example, in equation (5.2)  $\beta$  and  $\sigma_{t+1}^2$  may both depend on race (in a linear fashion) so that even if a race dummy is significant we cannot identify whether this is due to differences in discount factors or attitudes to consumption risk.

One possible alternative is to identify episodes in which certain state insurance schemes (such as unemployment insurance, health insurance, or old age pensions) were extended to different segments of the population and to trace in the micro data the reactions to these changes. This has some claim to being exogenous; the extension of a program (rather than a marginal change in the program for current members) is likely to be "large" and we can observe the timing of such extensions quite precisely. It may even be that some changes were large enough to induce observable changes in the aggregate data although such investigations will be plagued by the lack of a "control" group who experienced no change.

Yet another approach to assessing how important it is to allow for a precautionary motive in the empirical work would be to set up an exact Euler equation that nests the quadratic (CEQ) model as a special case and then to test directly for the significance of the extra "non-CEQ" parameters. This could be done using the method developed by Attanasio and Browning (1995) to derive their generalization of the CRRA model (see the discussion in Subsection 5.1 above). If the non-CEQ parameters are significant for

different groups then this indicates a significant (but not necessarily large) precautionary motive.

Table 5.2 presents what has been done. The most widely used measure of risk is income risk. The evidence on the importance of this is mixed. On the one hand, Skinner (1988) and Guiso, Jappelli, and Terlizzese (1992) find little or no evidence in favor of a precautionary motive whereas Carroll and Samwick (1995a, 1995b) find that the precautionary motive explains a sizable part of wealth holdings. It is still difficult, however, to assess how well income risk can characterize the saving and wealth distribution. For example, the studies which work with log wealth exclude households with nonpositive wealth; these represent a significant proportion of the population. Furthermore, it seems unlikely to us that the wealthy are significantly motivated by their fear of future income or consumption shocks. As we have seen in Section 3, a large proportion of saving is due to rich households which certainly bounds the possible quantitative importance of the precautionary motive due to income risk.

Other types of risk may be important but the empirical results in Table 5.2 do not give a strong indication that households that are not covered do indeed save more than otherwise similar households. As to other findings concerning, for example, portfolio composition, while these are suggestive they are not yet convincing.

Our reading of the evidence presented in the papers in Table 5.2 and other work on saving patterns is that while the precautionary motive is important for some people at some times, it is unlikely to be so for most people. Thus the Carroll and Samwick results suggest that the precautionary motive is strong for younger households who are not wealthy. The low level of consumption of young people who have very good lifetime pros-

pects also seems to us to argue for a substantial precautionary motive. On the other hand, we have already seen that wealthy households do much of the saving and they are unlikely to be subject to a significant precautionary motive. Similarly households in the later stage of the life cycle who have accumulated assets for retirement also have an effective buffer against short-run shocks. Yet another group that are unlikely to have a significant precautionary motive are those in steady jobs which have fringe benefits that provide effective insurance against a wide range of contingencies (tenured university professors provides an obvious example). Given all of this, it seems to us that the precautionary motive has some role to play in explaining saving behavior but it is unlikely to be as important as some studies suggest.

#### 5.4 *Tests of Other Implications of the Standard Consumption Model*

There are also other implications of the standard consumption model that have been examined in the literature. We discuss three here that exemplify different approaches. The first paper we discuss is Wilcox (1989). This paper uses macro data. As discussed in the introduction, we are skeptical that much can be learnt from aggregate time series data about individual behavior but work that uses the timing of specific events in this way does seem to be of value (see also Alan Blinder and Deaton 1985). Wilcox notes that there is a difference in timing between announcements and implementation of changes in Social Security benefits and looks for when consumption reacts. According to the standard additive model all changes in consumption should be made on receipt of the new information and not on receipt of the actual payment. Essentially, then, Wilcox is proposing an orthogonality test of the conventional kind but one in which



knowledge of the exact timing of an announcement is exploited. Using aggregate monthly data for the U.S. from 1965 to 1985 Wilcox presents evidence that consumption reacts to the actual change in benefits and not to the announcement of the change. Interestingly, most of the effect seems to be concentrated on the purchases of durables in general and automobiles in particular. This weakens the suggestion that significant liquidity constraints are driving Wilcox's results because cars can be used as collateral for loans.

Alessie, Michael Devereux, and Weber (1993) also present evidence that relies on the specific timing of a change in government policy, in this case imposed credit restrictions. Specifically they use the abolition of credit restrictions in the U.K. in 1982 to test whether household demand for cars was affected by the change. If the conditions of the standard model without liquidity constraints hold then the relaxation of credit restrictions should have no effect. If, on the other hand, liquidity constraints are important then we will observe a change in purchasing behavior at the policy change date. Using a quasi-panel constructed from U.K. FES data from 1973 to 1986 and National Transport Surveys for 1976 and 1986 (to give the stocks of cars held) they provide Euler equation results that allow for nonseparabilities between cars, durables, and nondurables. The most important of their findings from the formal model and from a more informal data analysis is that there is strong evidence that the abolition of credit controls led to a change in behavior in the way predicted by a model with liquidity constraints.

Yet another test of one of the implications of the standard additive model is given by Deaton and Christina Paxson (1994). They start from the observation that in a CEQ model, consumption should follow a random walk. Thus if we

follow a group of households over time we should see consumption "spreading out." Using time series of expenditure surveys from Taiwan, the U.K., and the U.S., Deaton and Paxson document very striking increases in the dispersion of consumption over time for the same cohorts (their figure 4, which shows dispersion against age, controlling for cohort, is particularly striking). They also show that the results are robust to plausible allowance for family size effects. Of course, this finding is consistent with almost any theory of consumption if income has a unit root so this is not in any sense a powerful test against alternatives but it is surprising how well the predictions of the simple CEQ model stand up to this very focused scrutiny.

We have presented brief accounts of these three studies to show some of the others ways that we can examine the implications of variants of the standard model. The method of Wilcox uses a divergence between announcement and implementation dates; the Alessie, Devereux, and Weber paper uses the timing of a policy change that removed a particular restriction in an important market and the Deaton and Paxson paper examines the implications for cohort inequality. All three papers cleverly exploit very different implications, each of which deserves further investigation but they also suggest that there may be other unexploited implications that are worth examining. Our feeling is that this style of investigation is likely to lead to more convincing and robust results than, say, further Euler equation estimates on the PSID.

## 6. Empirical Evidence on Life-Cycle Saving

### 6.1 Life-Cycle Saving Behavior

As stated in Section 2, we identify the standard model with the proposition that

agents seek to keep the marginal utility of expenditure constant from period to period. The Euler equations given in the previous section exploit this and the conditions for the standard additive model to examine short-run behavior but we can also consider long-run behavior. Broadly, agents should save so that consumption in retirement gives the same marginal utility as consumption earlier in the life cycle (with due allowance for any discounting). Note that this does not imply that consumption levels should be smoothed over time; fairly obviously households may “rationally” plan to spend more when there are children present and less when they are not working in the market (that is, after retirement). Additionally, declining health or vigor in older age may lead to planned (or anticipated) falls in consumption over the life cycle.

Because we do not have very long panels we cannot follow the same individuals from school to retirement and beyond. Thus we have to make auxiliary assumptions about the constancy of certain behavior over time or over the life cycle to examine longer run behavior. This typically makes an explicit comparison of marginal utilities across time impossible. Consequently we have to resort to more informal methods.

The simplest method of all to look at life-cycle behavior is to take one cross-section and graph means of consumption against age. This is the method adopted by, for example, Carroll and Summers (1991; see also Carroll 1993). Carroll and Summers graph a number of “life-cycle” consumption profiles (strictly graphs of consumption against age) for different education and occupation groups from the U.S. CES for 1960/61 and 1972/73. The most important finding in the Carroll and Summers paper is that for all education and occupation groups, the shape of the income and consumption

paths are very similar; they refer to this as the “consumption/income parallel.” Note that this “fact” does not assert that consumption and income are equal in the early life cycle (the 10% saving rate for 25–34 year olds given in Table 3.2 rules that out) but that they are trending in the same way.<sup>31</sup>

This tracking is inconsistent with a CEQ model, particularly for high education agents who have a (predictably) rising income profile. The coincidence between income and consumption in the early part of the life cycle is not, however, necessarily inconsistent with a standard model that allows a precautionary motive; see the remarks toward the end of Section 2.3 above.

It is important to emphasize that the graphs in Carroll and Summers (1991) do not follow the same agent over time. Thus they confound age and cohort effects. Moreover, education has an important cohort component which further complicates drawing inferences. There may also be selection effects when groups are defined on the basis of occupation which is clearly not fixed for any individual. Most importantly, Carroll and Summers do not control for other life cycle events that affect consumption and saving. Once we take such events into account it is not even clear that the evidence Carroll and Summers present is inconsistent with a simple CEQ model.

Attanasio and Browning (1995) present graphs that are similar to those of Carroll and Summers. The main difference is that Attanasio and Browning use several years of U.K. FES data to follow cohorts through time. They reproduce

<sup>31</sup>Note as well, that Donald Haurin, Susan Wachter, and Hendershott (1995) provide evidence from the NLS-Y that nonhousing wealth increases sharply in the early years of marriage as newly weds save for a house. This would show up as saving but disappear once the house is bought if “consumption” includes both mortgage principal payments as well as interest payments.

the finding that consumption and income move together over the life cycle. When they allow for demographics, however, all of the life-cycle variation in consumption disappears. Specifically, deflating consumption by plausible adult equivalence scales leads to a completely flat life cycle path for adjusted consumption (see also Blundell, Browning, and Meghir 1994). At a minimum, this suggests that the finding that consumption and income move together over the life cycle may have other explanations than that current income is "causing" current consumption. Of course, the demographics "explanation" of the life-cycle path of consumption still does not explain why unadjusted consumption is correlated with income. As discussed in Browning (1992) we believe it is extremely unwise to focus on two life cycle paths (income and consumption in this case) and make inferences about causality without considering other choices such as education; human capital formation; career choice; marriage; family composition; and labor supply. This is not to say that the life-cycle facts are consistent with a simple CEQ model but rather to suggest caution in drawing inferences concerning the validity of a particular variant of the life-cycle model from two life cycle paths.

In simulations of lifetime consumption paths, Hubbard, Skinner, and Zeldes (1994a, 1994b, and 1995) consider three sets of facts concerning wealth, saving, and consumption in the U.S. These are the typical ratio of assets to income in the population at any time, the age patterns of wealth and saving, and the short-run (five year) comovements of income and consumption. They employ a no bequest non-CEQ model with moderate discount rates and liquidity constraints. They find that this model can better fit the facts on these three issues than a CEQ model with liquidity constraints or

what they interpret as a buffer stock model. Hubbard, Skinner, and Zeldes (1994a) also estimate standard Euler equations on their simulated data and find results for excess sensitivity that are very close to those of Campbell and Mankiw (1990) on the aggregate data and Lusardi (1996) on the micro data (a coefficient for expected income growth of 0.4). Because these authors allow for both liquidity constraints and precautionary saving in these simulations it is not possible to identify which is the most important departure from the CEQ model.

This style of empirical work in which simulations are used to fit some features of the data is halfway to full dynamic structural modeling. Thus the three Hubbard, Skinner, and Zeldes papers use dynamic programming techniques to simulate paths for agents in realistic settings. However, rather than estimating the parameters of the utility function they fix them and then use informal goodness of fit measures (literally comparing columns of predicted and actual) to evaluate different configurations of the parameters. Consider, for example, the discount factor. Only three values are considered (1.5% and 3% for the "benchmark" models and 10% for the buffer stock model) and these are taken to be fixed within education groups (although allowance is made for the uncertainty of life so that there is effective higher discounting in old age). It would be highly desirable to allow for more heterogeneity in the parameters of the model and to allow that these may be correlated with, for example, the "choice" of income processes that agents make (see the remarks at the end of Section 2.3 concerning the simulations of Carroll and Attanasio et al.). However, because the present methods use vast amounts of computer time it is perhaps overly ambitious to suggest full struc-

tural modeling but it is the obvious next step.

### 6.2 *Saving For and In Retirement*

In the original life cycle model of Modigliani and others, saving for retirement played a particularly important role. It is thus appropriate to consider explicitly saving for retirement and saving in retirement. We focus attention on three main questions: do younger people save enough for retirement? Do government incentives to increase saving for retirement actually increase saving? Do the elderly dissave? The latter not only has intrinsic interest but it is also important since all standard consumption models predict that eventually households will start to dissave whether or not there is a bequest motive or uncertain lifetime (see, for example, Hurd 1990). Thus this prediction can be considered a "critical experiment" for the life-cycle model in its most general form.

We start with the issue of whether agents save enough for their retirement period. There are at least three problems here. The first is, how do we define "enough." In a standard model this depends on preference parameters and the real rate of interest. If the discount factor is higher than the real rate of interest (as is often assumed in, for example, buffer stock models) then agents may "rationally" plan to have low consumption in later life. For example, an agent with a log consumption utility function who has a discount factor that is two percentage points above the real rate will plan to have consumption that is twice as high at 35 as at 70. This implies that if there is a good deal of heterogeneity in discount factors then we may observe many agents in the population arriving at retirement with low or negative assets. Furthermore, if there is uncertainty but there are also some safety nets or some public provisions which are asset-tested,

then holding little or no assets can even be an optimal strategy.

The second issue is: "enough" for whom? Browning (1994) documents that for the "average" married couple the wife is typically younger than her husband and will typically survive to a greater age. Combining these two factors he finds that a wife can expect to live about 50 percent longer in the retirement period than her husband. Thus husband and wife may have very different views about what is enough for retirement unless they are perfectly in sympathy.<sup>32</sup> This simple observation has wide-ranging implications. For example, the level of saving by a household depends not only on the level of household income but also on the distribution of income within the household. This in turn means that for some distributions the marginal propensity to save is not defined: it can be anything between zero and unity depending on who receives the extra income (wives having the higher marginal propensity to save). Similarly, the age distribution within the household also affects the level of saving and we can no longer talk of the "age of the household" but only of the ages of its members.

The third issue is how do we measure savings that are made for retirement? There are definitional and measurement problems. On the definitional question: as discussed in Section 2, once we move away from a CEQ model it is not clear what the sum of current assets and the expected flow of future funds represents. Thus it is problematic to aggregate liquid

<sup>32</sup> This is part of a much larger literature that is emerging on intrahousehold allocation. One as yet uninvestigated area that may be of signal importance for savings behavior is the effect of possible family dissolution. If we introduce the possibility of divorce into our life cycle models then this may undermine many of the predictions that we currently derive from "unitary" (single utility function) models of the household.

assets and housing wealth, future Social Security pension receipts, and entitlements to free medical care after retirement. Even the usefulness of the sum of current assets in tax sheltered instruments and other financial assets depends on the context. For example, Eric Engen and Gale (1993) show that the early withdrawal penalty on Individual Retirement Accounts (IRA's) provides a theoretical justification for IRA saving and non-IRA saving to be imperfect substitutes for those some time away from retirement.

As well as the question of how we aggregate different assets is the question of how we can measure them. The new Health and Retirement Survey (HRS) and the Survey of Asset and Health Dynamics Among the Oldest Old (AHEAD) incorporate new survey techniques that result in substantially smaller biases resulting from missing wealth components. One of the striking findings is that household wealth holdings reported in these data set are substantially higher than the figures reported in other surveys, which suggests that wealth generally tends to be underreported (see Thomas Juster and J. Smith 1994).

With these considerations in mind, we start examining some of the evidence provided in the papers that examine this issue. Direct evidence on the adequacy of retirement saving is provided by Daniel Hamermesh (1984). He concludes that for couples, consumption early in retirement exceeds by 14 percent the income that their financial, pension, and Social Security wealth can generate. He finds that they respond to this insufficiency by reducing their consumption as they age. This finding, however, is dependent on the imputation method that Hamermesh uses for total consumption and is also at odds with the evidence presented earlier which suggests that saving is typically positive for households

just after the conventional retirement age (see, for example, Table 3.3). James Banks, Blundell, and Sarah Tanner (1995) also examine consumption patterns directly and conclude that while some of the fall in consumption after retirement can be rationalized within a standard model that allows for complementarities between consumption and labor supply, there is still an additional "unexplained" fall in consumption.

A number of studies have documented the very great heterogeneity in wealth levels at retirement (see Peter Diamond and Jerry Hausman 1984; Venti and David Wise 1993; and Gustman and Juster 1995). Very many households enter retirement with very little in the way of financial assets and not very much in wider definitions of wealth that include housing equity. On the other hand, some households have high levels of wealth that can obviously finance high post-retirement consumption levels or bequests. Another consistent feature of estimates of wealth holdings is how these vary across family types (see, for example, Kennickell and Shack-Marquez 1992; the U. S. Congressional Budget Office 1993; and J. Smith 1994). Typically, married couples have the highest levels of wealth and lone parents the lowest with singles in between (but with quite low levels of wealth). This mirrors the pattern for saving given in Section 3. Finally, wealth levels at retirement seem to be highly correlated with education levels: low levels of wealth are found for those with the lowest level of education.

In a series of papers, Bernheim (1993, 1994a, 1994b) has examined the adequacy of accumulation by "baby boomers" (those born between 1946 and 1964) to provide for retirement. According to his calculations, the typical baby boomer is saving at one-third the rate required to finance a standard of living during retirement comparable to the standard of liv-

ing that it enjoys before retirement.<sup>33</sup> He argues that the parents of the baby boomers also decreased their saving with respect to previous generations but they benefited from a series of fortuitous developments which will not be available to baby boomers. For example, real social security benefits increased dramatically during the 1970s and private retirement benefits were significantly expanded and improved during the same period. Additionally, they (the parents) experienced a period of high inflation that wiped out much of their liabilities and finally they enjoyed a sharp increase in the relative price of housing which created big windfall gains. If baby boomers rely on what their parents have saved, they may be misguided in their judgments. According to Bernheim, baby boomers are not only financially vulnerable but they may not even perceive correctly their vulnerability.

A study from the U. S. Congressional Budget Office (1993) on this issue came out with somewhat different conclusions. While some of this study's findings agree with Bernheim (for example, the less educated are making less provision for retirement) there are critical differences which derive from the measure of wealth chosen to evaluate the adequacy of accumulation. Whether or not one includes the value of housing equity in counting the assets available for consumption at retirement makes a big difference. From the CBO study, assuming that housing wealth will not be used to finance retirement reduces available resources by a factor of three at the median. Home

ownership was an important factor in the accumulation of wealth in the 1980s. Young households who are homeowners show a relatively higher wealth-to-income ratio in 1989 than in 1962 and those who do not own their homes show similar or lower wealth to income ratios. The CBO study expresses concern that the nonhomeowners may be unable to accumulate wealth at a rate that is sufficient to give them a comfortable life in retirement.

It is clear that the house is an important asset in the household portfolio. Kennickell and Shack-Marquez (1992), for example, report that the principal residence accounts for 32.2 percent of the assets of the household sector in 1989. However, one can argue whether housing wealth provides a good vehicle for consumption at retirement. In a pair of studies Venti and Wise (1989, 1990) show that there is little decumulation of housing equities and what decumulation there is, is observed only very late in age. Sally Merrill (1984) finds that the elderly with few liquid assets or low income are no more likely to trade down their housing equity than other elderly. On the other hand, Louise Sheiner and Weil (1992) find some evidence that households reduce home ownership as they age, even though they estimate that 42 percent of households will leave behind a house when the last member dies. Even though reverse annuity mortgages are now available, there seem to be little use of them (see Venti and Wise 1991).

Thus it seems that a substantial fraction of U.S. households will depend on Social Security for support in retirement. As against this, a substantial minority of households are now holding assets in targeted retirement saving accounts. This is the second issue that we examine: the effect on saving of schemes such as IRA's and 401k's. These are schemes which raise the rate of return on saving for re-

<sup>33</sup> This "one third" estimate should be treated with caution: it refers to nonpension saving. Thus if the optimal level of post-retirement consumption is to be financed from Social Security, an occupational pension, and private saving and the latter provides, say, 30% of the income to do this, then the "one third" refers to the latter and post-retirement consumption will be only 20% below the optimal level.

tirement by allowing contributions to be made out of gross income and also exempt income from the assets purchased from tax.<sup>34</sup> The theoretical impact of the introduction of such schemes on aggregate saving is ambiguous. There may be a positive effect for current nonsavers some of whom may now be induced to save by the higher return. However, this positive increment may be offset by the behavior of current savers. For them, the introduction of such a scheme has the usual negative income effect and positive substitution effect; the net effect is ambiguous. Thus we must have recourse to the data to sign the aggregate effect.

We do not have the space here to do justice to the literature on saving incentives; see Poterba, Venti, and Wise (1993, 1994), Engen, Gale, and Scholz (1994), and Gale and Scholz (1994b) for different views of this controversy and Hubbard and Skinner (1995) for a thorough and balanced review. The important point is that empirical work in this area confronts a serious identification problem. Although there is widespread agreement that in any cross-section there is a positive correlation between wealth and participation in "targeted" saving schemes there is no consensus about the inference that can be drawn from this. The positive correlation is consistent with the existence of heterogeneity in "tastes for saving" (or discount rates) and with substitution effects (including the entry of new savers) overcoming income effects. Different authors have adopted

different approaches to identification but none of these command universal agreement. In their review of the evidence, Hubbard and Skinner (1995) conclude that there is some short run impact on net saving and even larger long run effects.

The other question we began with is whether the elderly dissave. In the simplest life cycle model with no bequests and no uncertainty about the life span, decumulation should begin at retirement. Introducing uncertain lifetime and a bequest may push back the age at which saving becomes negative but it does not invalidate the prediction that the elderly will eventually start to dissave. Although this area could bear more theoretical investigation<sup>35</sup> this does seem to be one of the robust predictions of the life-cycle model because it is difficult to believe that liquidity constraints are important in later life and earnings risk is unimportant.

This issue has been widely investigated and in fact it represented the first attack on the simple life cycle model (see the review provided in Hurd 1990). We have seen that the wealth accumulated in housing equity shows little tendency to decline. Do other types of wealth show any decumulation? The critical point to note here is that to correctly establish whether the elderly decumulate we need to have panel data.

We cannot simply compare wealth holdings or saving of different age groups. The evidence from cross-sectional data (see, for example, Table 3.3) confounds age and cohort effects (see Anthony Shorrocks 1975). An alternative

<sup>34</sup> IRA's became available in 1982 and reached their greatest popularity in the year before the Tax Reform Act of 1986. Holdings of such accounts are currently estimated at about \$10 billion. 401k plans were created by 1978 legislation and became widely available in the early 1980s. Between 1983 and 1990, the number of participants in 401k plans rose from 4.4 to 20.8 million. Personal retirement assets increased over fourfold between 1984 and 1991, much more than any other component of wealth (see Poterba, Venti, and Wise 1994).

<sup>35</sup> For example, we believe that an additional area that merits further theoretical investigation is the consequences of illness or a diminished "zest for life" which tends to "kink" the marginal utility of money and reduce the desirability of current consumption as against bequests (see Axel Börsch-Supan and Konrad Stahl 1991; and Börsch-Supan 1992).

is to follow the same cohort through a series of cross-sections, a technique which has proven useful for pre-retirement households. For the elderly, however, this suffers from the fact that mortality is negatively correlated with wealth and that the poor are more likely to live with their children or enter nursing homes (which means that they would drop out from the sample or be part of other households). This introduces a bias in the cohort average over time because the older the cohort the higher the proportion of those who had high wealth at retirement. We have also to be careful about family composition because the decumulation of couples can be lower than singles given that the expected "lifetime" of the household is greater for couples.

In panel data, however, we can handle these problems by considering only a sample of households who survive to a late age and following their asset levels through time. Using this technique, Hurd (1990) presents evidence of decumulation in later old age.<sup>36</sup> Although this finding provides comfort for advocates of life-cycle models it does little to settle whether, for example, liquidity constraints are important for younger people. Thus if this finding turns out to be robust then it provides evidence in favor of using the standard model in general but not of which variant (CEQ or non-CEQ, with or without habits and liquidity constraints). There are many investigators, however, who feel that the life-cycle framework itself is too restrictive and that other ways of looking at behavior provide a better understanding of saving behavior. In the next section we present some of the relatively new work that uses a "behavioral" framework.

<sup>36</sup> Decumulation is, of course, only a necessary condition for the standard model and not sufficient; we must also take account of the rate of decumulation.

## 7. Nonstandard Models

Johnny Hodges played with the Duke Ellington band for over 30 years. During all that time Ellington paid Hodges daily; the reason for this was that if he paid him weekly then Hodges would go hungry for six days of the week. Evidently Hodges had a considerable problem with self-control. Recent behavioral models of saving have posited that most people have a self-control problem and that this invalidates straightforward application of a standard life cycle model (see Thaler 1990, 1994; and David Laibson 1994).

A second feature of the lifetime allocation problem that behavioral economists emphasize is the complexity of the dynamic optimization problem that agents face (see, for example, Bernheim 1993). This may be overcome if the problem is one that many people face and where outcomes are revealed in a relatively short time because then agents can observe others and "rules of thumb" may be developed. At a minimum, glaring mistakes can be avoided. This route is not available for people aged, say, 40 in 1994 who are thinking about saving for retirement. The demographic composition of the population, the level of development of the economy and of support for the currently old has changed so much in the past 30 years that looking at what their parents, for example, did is likely to be a very poor guide. Against this, we might remark that the size of errors that Bernheim (1993) suggests some people are making could be avoided by fairly crude programs if these agents were indeed interested in saving as much as Bernheim suggests they should: we do not need the exact solution, only a good one. The point remains, however, that we can question whether the assumption of unbounded computational abilities used in our model of eco-



conomic decision making is viable. Thaler (1994), for example, advocates models of bounded rationality as a better characterization of individual behavior.

The third putative failing of the standard framework is the assumption of fungibility. The marginal propensity to spend out of different sources of wealth (increases in housing equity due to increases in house prices, changes in future pension rights, etc.) is not the same. Behavioral economists posit that individuals create "mental accounts" for their different assets causing their marginal propensity to consume from those assets to vary with the level of temptation associated with each one. Thaler suggests that this non-substitutability is not consistent with a life-cycle model. The imputation of this implication to the standard framework seems to follow from an identification of the latter with the CEQ model. As we have seen, it is by no means a prediction of the model without certainty equivalence that agents will treat all sources of expected income and wealth identically. In particular, the existence of a precautionary saving motive breaks the perfect substitutability of assets. Another example is when there exists liquidity constraints. If consumers cannot borrow against some of their assets, we would observe that less liquid assets have a lower marginal propensity to consume.

It is instructive to consider in more detail one typical example cited by behavioral economists: the case of Christmas clubs. Such a club requires a fixed weekly payment throughout the year and then pays out the amount saved at the end of the year. The existence of such clubs poses a problem for standard models because the rate of return is usually low (because administration costs are high) and agents are "locked" in during the year. Thus a Christmas club provides a lower return and less flexibility than a

conventional saving account. Two salient features of the Christmas club example seem important to us. First, the consumption path that agents actually achieve (lower consumption during the year and higher consumption at the end of the year) is the same path that a forward looking agent with no self-control problems would achieve by saving in a bank. Put another way, Ellington and Hodges did manage to find some mechanism that ensured that Hodges ate every day. Thus the predictions of the standard model for consumption paths would be essentially correct. On the other hand, the predictions of the standard model for portfolio behavior are wholly unable to account for the specific asset position taken. It is our belief that this applies more generally: if the standard model (with or without liquidity constraints) fails in the direction of agents not exercising self-control it is likely to be in predictions of portfolio behavior and not the actual consumption paths realized.

More effort is required of both behavioral economists and economists who use the standard life cycle framework to achieve more understanding. Thus protagonists of the standard framework (among whom the first coauthor includes himself) would ask: what specific features of the data that are regularly used (the PSID or quasi-panels, for example) are better rationalized within a behavioral framework rather than a standard framework? On the other hand, advocates of a behavioral position can reasonably ask: can the "anomalies" that they identify really be rationalized within a life-cycle framework? We emphasize here that we should not tie our hands behind our backs and use only a CEQ model with limited heterogeneity (in tastes and environment). The remark by Thaler (1994) that in the standard life cycle framework "the only policy variable [to increase the U.S. saving rate] is the

after-tax rate of return" ignores the theoretical developments of the past ten years.

To take another example of possible cross-fertilization, consider the source of preferences. Many users of the standard model are willing to allow that there are differences between cohorts in attitudes to saving. The inclusion of cohort "dummies" in a consumption or saving equation, however, is really an admission of ignorance. Bernheim's suggestion that attitudes to saving are partly determined by the environment in which people grow up is surely correct but not much more useful than including cohort dummies. The modeling of cohort effects would gain from a more precise specification of exactly how the environment matters so that we could predict, for example, whether people coming to maturity now have attitudes that are closer to those born in the early part of the century than they are to those born in the late 1940s. Along this line, Arie Kapteyn, Alessie, and Lusardi (1995) present results that suggest that we can replace cohort dummies in a saving equation by the level of per capita income in the year in which the head of the household was 22.

As an illustration of the progressive strategy of seeking for features of the data that are inconsistent with one view or the other, we quote Bernheim (1994b, p. 69) who uses the fact that non-college graduates save very little to argue that general economic literacy is an important determinant of saving behavior. According to him,

patterns of wealth accumulation among those without a college degree bear little or no resemblance to the pattern that should emerge from sophisticated decision making. In contrast, those with college degrees not only save more adequately for retirement, but also generally behave in a way that more closely resembles the outcome of sophisticated planning.

Implicitly, then, this seems to be an argument against using the standard framework for less educated agents. Within the standard framework, however, one explanation for this observation would be that there is heterogeneity in discount factors and this leads some agents to choose less schooling and less consumption in later life (relative to their earlier life) than their better educated contemporaries.

Thaler (1994) suggests that allowing that some people have a high discount rate "renders the theory empty" which is a position we agree with if we are looking at just one narrow aspect of behavior. What gives the standard life cycle framework real bite is that we must account for a whole range of behavior (short- and long-run saving, schooling, and occupation choice, fertility choice, portfolio decisions, retirement decisions, etc.) *with the same set of parameters*. Therefore the same parameters should explain the saving behavior at different stages of the life cycle, the wide heterogeneity of wealth across households, and the reasons why aggregate saving rates change over time, to mention just a few of the facts that we have considered in this survey. This is an ambitious undertaking which we have hardly yet begun, much less tried and discarded.

## 8. Conclusions

We began this survey with a list of motives for saving. This list seems complete and sensible; a satisfactory theory of consumption and saving should encompass most of these motives. Our discussion of the standard optimizing framework in Section 2 indicates that this "model" can do this. Thus the CEQ model allows for the life-cycle, intertemporal substitution, and bequest motives. The more general standard additive model adds in the precautionary motive which has been the fo-

cus of much of the theoretical work of the past decade. Finally, dropping the “additive” assumptions we can incorporate habits and imperfections in the capital market. Thus the standard model provides a powerful and flexible framework for organizing our thoughts. If the standard model ultimately fails to adequately explain the facts then it is not because a more sophisticated version is required but because it is the wrong way to think about household decisions on consumption and saving.

As to the facts themselves, we have a variety of data sets that provide us with information on household saving. In Sections 3, 4.1, and 6 we presented some facts about saving behavior. While these data provide a more or less accurate description of who saves and how this has changed over time, they are much less effective in helping us to answer the basic question of why people save.

If we accept that the very intensive effort to identify the importance of different motives for saving using currently available data sets has not led to much consensus, then it seems that the road to robust identification lies in collecting more and “better” data. Specifically we need data that are directly informed by the theory to produce more focused sample design. To take one example, consider the debate concerning the saving behavior of the elderly. To assess whether behavior is consistent with the theory we need information on, for example, health status, subjective perceptions of mortality risk, and the situation of any children. This requires the development of new questions to elicit these variables. This is one of the avowed intentions of the AHEAD and HRS surveys listed in Table 3.1.

As another example, consider the question of the relative importance of the precautionary motive and liquidity constraints in explaining consumption

growth. Referring back to equation (2.8) we see that the two terms for these (the variance term,  $\sigma_{t+1}^2$  and the Lagrange multiplier,  $\psi_t$  respectively) are both unobservable. As we discussed at length in Section 5, it has turned out to be difficult to separate these two effects. Given the effort that has gone into doing this on currently available data sets it seems likely that some new survey questions that identify observable exogenous correlates for the variance term and for the liquidity constraint Lagrange multiplier are needed. Questions such as those in the SCF that relate to being refused credit represent a step in that direction.

As we emphasized in the theory section, one of the great virtues of the standard model is that it integrates short-run and long-run consumption decisions in a coherent way. Thus the parameters that enter the Euler equation for the determination of consumption changes from period to period are the same as those that govern the allocation of resources between the present and the distant future. Ideally we should estimate jointly Euler equations and long-run (levels) consumption functions to parameterize our standard models. This seems to be analytically and computationally infeasible at present. A promising intermediate step is simulation models with parameters chosen either by taking values from other studies (for example, Hubbard, Skinner, and Zeldes 1995) or from Euler equation estimates (for example, Attanasio et al. 1995).

Although simulation models face difficulties such as the sensitivity of outcomes to terminal conditions and the need to keep the number of specific institutional and demographic factors small to economize on computing needs, this seems the immediate way forward. One relatively unexplored area here is the importance of heterogeneity across the population in explaining cross-section

variation. Some of this heterogeneity is usually observed (for example, the number of children in the household); some is rarely or never measured but is potentially observable (for example, expectations concerning inheritances) and some is potentially very difficult to measure (for example, how risk averse or prudent the agent is). At present we allow for the former two in simulations by giving households exogenous paths for these variables. For unobservable heterogeneity, it would be useful to allow for random (but perhaps correlated) heterogeneity in, for example, the parameters governing the discount rate, intertemporal substitution and prudence<sup>37</sup> in our simulations. It is an open question as to how much of the data can be "explained" just with heterogeneity of this sort.

More ambitiously, it is desirable in future to integrate a whole range of life-cycle decisions such as marriage and fertility decisions, education and career choice, and intergenerational transfers. In all of this modeling, standard dynamic programming techniques can be brought to bear for these simulations because they derive from the standard optimizing model. What of nonstandard models?

At present, the only coherent alternatives to the standard model are behavioral models. These have the great virtue of putting saving at center stage whereas the standard model reduces saving to a residual between income and the consumption that is determined within the model. They also emphasize elements of behavior (such as self-control and limits on computational power) which seem important intuitively. On the other hand, it is not clear that these models lead to sharp predictions that can be tested on the data sets so widely used to test various versions of the standard model. One

immediate next step would be to explore how far we can reconcile behavioral models and standard optimizing predictions. More ambitiously, it may be that the heterogeneity that we allow for in standard models can be linked to psychological factors. This will allow parsimonious modeling of heterogeneity and may provide a link across many different life cycle decisions.

Above we have reviewed a great deal of high quality research on the theory and evidence concerning the saving behavior of households. Although substantial progress has been made in the past 15 years, more problems remain than have been satisfactorily answered. The broadest of these questions is whether the standard theory is of much use in understanding saving behavior. If it is, then we can expect rapid progress in understanding as new and better data becomes available. The combination of a rich and flexible theoretical framework, good data, and appropriate econometric techniques promises much: we look forward to seeing the new results.

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<sup>37</sup> Such a three parameter model would, of course, require something other than the usual iso-elastic utility function.

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